Printed on Thin Paper for Foreign Circulation.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

VOL. CLIV.—No. 4014] LONDON: FRIDAY, DECEMBER 16, 1932 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

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Northampton Polytechnic INSTITUTE,
ST. JOHN-STREET, LONDON, E.C.1.

APPLICATIONS are INVITED for the POST of HEAD of the CIVIL and MECHANICAL ENGINEERING DEPARTMENT.

Particulars of the appointment and application form will be forwarded on request.

Salary scale, £780-25-930, less 10 per cent. "economy" reduction.

It is possible that an initial salary in excess of the minimum may be authorised should this appear warranted by the successful candidate's previous experience in a department of equivalent standard.

Applications should be accompanied by copies of three testimonials, and should be submitted not later than January 20th, 1933.

The candidate appointed will be required to enter upon his duties on June 1st, 1933.

S. C. LAWS, M.A., M.Sc.,
9252 Principal.

University of Bristol.

Convocation of the University of Bristol has appointed a Committee to compile a Register of Past Students (A) of the University; (B) of University College, Bristol; (C) of Bristol Medical School; (D) of the Merchant Venturers' Technical College; and (E) of the Day Training Colleges, prior to incorporation in the University. Past Students of any of these Institutions who have not received an individual invitation to supply the information required by Convocation are asked to assist in making the Register complete by communicating as soon as possible with the SECRETARY to CONVOCATION, University of Bristol, who will furnish them with the appropriate form for completion. 9274

County Borough of Swansea.
ELECTRICITY DEPARTMENT.
CONDENSING PLANT FOR POWER STATION AT TIR JOHN NORTH.

The Corporation invites TENDERS for the SUPPLY, DELIVERY and ERECTION of the CONDENSING PLANT for the new Power Station at Tir John North, viz.:—

SECTION "B."—CONDENSING PLANT.—Two Surface Condensers, each having an area of 30,000 sq. ft., and each complete with Circulating Water Pumps and Motors, Pipe Work, Condensate Extraction Pumps, Air Ejectors, &c.

The works are unemployment relief works, and will be subject to conditions laid down by the Government Unemployment Grants Committee.

On and after 19th December, 1932, plans may be seen, and the general conditions, specifications, and form of Tender, in duplicate, obtained at the office of the Consulting Engineers, Messrs. Preece, Cardew and Rider, 8, Queen Anne's-gate, Westminster, S.W.1, on deposit of Five Guineas, which will be returned on receipt of a bona fide Tender (not subsequently withdrawn).

Additional copies may be obtained on receipt of £1 1s. for each copy, which will not be returnable.

Sealed Tenders must be received by the undersigned not later than Twelve Noon on the 19th January, 1933.

The lowest or any Tender will not necessarily be accepted.

H. L. LANG-COATH,
Town Clerk.

The Guildhall, Swansea,
15th December, 1932. 9277

County Borough of Swansea.
ELECTRICITY DEPARTMENT.
OVERHEAD ELECTRIC TRAVELLING CRANES FOR POWER STATION AT TIR JOHN NORTH.

The Corporation invite TENDERS for the SUPPLY, DELIVERY and ERECTION of the following:—

(A) ONE 150-Ton OVERHEAD ELECTRIC TRAVELLING CRANE for the Turbine Room.

(B) ONE 15-Ton OVERHEAD ELECTRIC TRAVELLING CRANE for the Circulating Water Pump Bay.

The works are unemployment relief works and will be subject to conditions laid down by the Government Unemployment Grants Committee.

On and after 16th December, 1932, the general conditions, specification, and form of Tender, in duplicate, may be obtained at the office of the Consulting Engineers, Messrs. Preece, Cardew and Rider, 8, Queen Anne's-gate, Westminster, S.W.1, on deposit of Five Guineas, which will be returned on receipt of a bona fide Tender (not subsequently withdrawn).

Additional copies may be obtained on receipt of a fee of £1 1s. for each copy, which will not be returnable.

Sealed Tenders must be received by the undersigned not later than Twelve Noon on the 6th January, 1933.

The lowest or any Tender will not necessarily be accepted.

H. L. LANG-COATH,
Town Clerk.

The Guildhall, Swansea,
14th December, 1932. 9276

The Dublin and Blessington STEAM TRAMWAY (ABANDONMENT) ACT, 1932.

The Committee of Management of the above Tramway shall be open after 1st day of January, 1933, to receive TENDERS for the PURCHASE and REMOVAL of the PROPERTY of the UNDERTAKING, as follows:

SECTION A.—Permanent Way, comprising approx. 16½ miles of rails, sleepers and fastenings, stone curbings, &c.

SECTION B.—Rolling Stock, comprising steam locomotives, petrol rail cars, steam trailers, open and covered wagons and timber bogies.

SECTION C.—Contents of Templeogue Workshop, lathes, power hammer, shearing machine, smith hearths, &c. &c.

SECTION D.—One 10-Ton Cart Weighbridge, by Pooley and Son, table 12ft. by 7ft.

NOTE.—Section C can be seen working up to 31st inst., during ordinary working hours, on previous application to the undersigned.

The Committee of Management do not undertake to accept the highest or any Tender, nor will they accept any responsibility for any description or quantities as stated above or elsewhere which are given for general guidance only. Tenderers must satisfy themselves regarding all and every part of the material for which they Tender.

Tenders will be received at this office up to Saturday, 21st day of January, 1933.

Full particulars regarding conditions from
GEO. GIBSON,
Secretary.

Offices: Turnure, Co. Dublin. 9272
K. A. A.

PUBLIC NOTICES.

Metropolitan Water Board.
TURBINE CONNECTIONS, KEMPTON PARK PUMPING STATION.

The Metropolitan Water Board invite TENDERS for the LAYING and JOINTING of approximately 126 LINEAL YARDS of 42in. diameter and approximately 24 LINEAL YARDS of 30in. diameter CAST IRON WATER MAIN, together with ANCILLARY WORKS in connection therewith, including, inter alia, the LAYING of SCOUR PIPES and CONNECTIONS, the FIXING of VALVES, &c., the LAYING of SEWERS, PIPES, CABLES, &c., and other contingent WORKS, at their Kempton Park Pumping Station, Hanworth-road, Sunbury Common, Middlesex.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201) on and after Monday, 12th December, 1932.

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained on and after Monday, 19th December, 1932, from the Chief Engineer on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. to 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Turbine Connections—Kempton Park Pumping Station," must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Monday, 9th January, 1933.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C.1,
5th December, 1932. 9246

SITUATIONS OPEN.

A CHIEF DRAUGHTSMAN, with Wide Experience in Marine Engine and Boiler Design, is REQUIRED.—Applications, stating age, qualifications and salary required, to be addressed in confidence to the MANAGING DIRECTOR, Central Marine Engine Works, West Hartlepool. P3060 A

PUBLIC NOTICES.

STEAM BOILERS FOR SALE.

The Irish Free State Electricity Supply Board have for immediate DISPOSAL the following PLANT at Pigeon House Electricity Station, Dublin:—

SIX LANCASHIRE BOILERS:
Manufactured by Babcock and Wilcox in 1903; with Bennis Mechanical Stokers and Superheaters.
Capacity of each boiler, 10,000 lb. of steam per hour.
Pressure, 175 lb. per square inch.
Temperature, 500 deg. Fah.
Heating surface, 1760 square feet.
Diameter of each boiler, 8ft. 6in. by 30ft. long.

FOUR WATER-TUBE BOILERS:
Manufactured by Babcock and Wilcox in 1903 with Bennis Chain-grate Stokers and Superheaters.
Capacity of each boiler, 100,000 lb. of steam per hour.
Pressure, 175 lb. per square inch.
Temperature, 500 deg. Fah.
Heating surface, 3140 square feet.

The plant is in good order and may be inspected at any time.

Tenders, under sealed cover and endorsed "Tenders for Plant, Pigeon House," should reach the undersigned not later than 20th December, 1932.

THE SECRETARY,
Electricity Supply Board.
60/62, Upper Mount-street, Dublin. 9273

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The Engineer

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This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

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9233 I

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For continuation of For Sale Advertisements see page 54.

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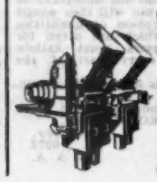

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A Seven-Day Journal

Chief Engineer-Surveyor—Lloyd's Register of Shipping.

THE General Committee of Lloyd's Register of Shipping, at a special meeting held on Thursday, December 8th, conferred upon Mr. Stanley F. Dorey, D.Sc., the appointment, as from January 1st, 1933, of Chief Engineer Surveyor to the Society, which position had been rendered vacant by the death of Mr. H. A. Ruck-Keene, M. Inst. C.E. Dr. Dorey has had a distinguished career. He served his apprenticeship at the Chatham Royal Dockyard, and in 1912 gained a Whitworth Exhibition and a Lloyd's Register Scholarship at Armstrong College, Newcastle-on-Tyne, where in 1914 he secured the degree of B.Sc. with distinction in engineering, and was awarded a research studentship. In August, 1914, Dr. Dorey was given a commission in the Durham Light Infantry, and in January, 1915, was transferred to the Royal Navy as an engineer and served in that capacity until the end of the war. He was appointed a Surveyor to Lloyd's Register in October, 1919, and has been stationed at Swansea, Glasgow, and Greenock, and latterly in London as a Principal Surveyor on the Chief Engineer Surveyor's staff. He was awarded the degree of Master of Science in 1922, and in June, 1932, that of Doctor of Science. He is a member of the Institution of Mechanical Engineers, the Institution of Naval Architects, the North-East Coast Institution of Engineers and Shipbuilders, and a member of the Council of the Institute of Marine Engineers.

Research on Steel Structures.

THE announcement is made that the British Steelwork Association and Imperial Chemical Industries, Ltd., have set up a joint committee, in order to investigate the various problems presented by the adaptation of modern methods of design and modern materials in the production of cheap and efficient structures. This joint step towards co-operative effort is, we are informed, founded on the realisation that many of the problems which are associated with present-day structural requirements can only be solved by a far closer association between the metallurgist and the chemist than has been possible in the past. It is now recognised that a vast amount of reconstruction is urgently required, particularly in our crowded city areas. It, it is said, can only be undertaken on a large scale if the most economic use of steel and other component materials is found out and applied to the structural problems involved. Such a task calls for systematic study and research which, it is felt, the British Steelwork Association and Imperial Chemical Industries, Ltd., should be particularly well equipped to undertake.

Advertising Exhibition.

THAT nearly half the space available at Olympia for the Advertising and Marketing Exhibition and Conference, which is to be held there from July 17th to 22nd, next year, has already been booked, was announced at a luncheon given by Major the Hon. J. J. Astor, President of the Advertising Association, to members of the general committee of the Exhibition at Dorchester House, on December 8th. "If," said Major Astor, "you advertise when trade is on the upward trend you stand to garner a good harvest; if on the down grade, you will, at any rate, parachute and not plunge. It is the old lesson that those who advertise wisely in a period of slump are the first to profit in the ensuing recovery. The earthquakes of the last few years have shaken the world and altered the field of our future trade. Old markets have vanished; new ones are appearing. The nations of the world are changing in habits and outlook, and advertising and marketing must adjust themselves to the new conditions, or they will fail. The Exhibition and Conference next July will be a reconnaissance in force of a post-slump world." The Ottawa Conference, he continued, had introduced new agreements into inter-Imperial trade. They had laid firm foundations on firm ground. Through them a challenge had been issued to British enterprise and British industry was anxious to respond. That being so, this was the time for advertisers and salesmen to get busy.

The Manœuvring of Ships.

A PAPER giving the results of recent experiments on the manœuvring of ships which have been carried out in the Alfred Yarrow Tank at the National Physical Laboratory, Teddington, was presented by Mr. G. H. Bottomley, of the Laboratory staff, to the North-East Coast Institution of Engineers and Shipbuilders at their meeting in Newcastle on Friday last, December 9th. A comprehensive research on the manœuvring of ships has been in progress at the Laboratory for a number of years, and results have been published from time to time. The experiments now described have been made with semi-balanced rudders behind a self-propelled model of a 400ft. twin-screw vessel, of the type capable of 10 to 15 knots. Various shapes of rudder have been tested and compared with respect to the rudder torques and pressures, and also to the manœuvring moments upon the ship as a whole. The results show that the outline of rudder affects the manœuvring moment, and that an improved moment can be obtained by designing the shape of the rudder so that a greater part of its axis of rotation can be placed directly behind the deadwood of the stern, leaving the lower portion of the rudder area free to balance. The torques on the rudderhead for the semi-balanced rudder, as would be expected, were considerably less than those for the unbalanced rudder. A streamlining of the sheathing of the rudder reduced the rudder forces and manœuvring moments as compared with those of the plate type of rudder. Measurements were also made of the effect upon the rudder of the propeller races and the relative values of rudder torques when the ship moves astern as compared with those when she moves ahead. A formula for determining normal pressures on the rudder was given in the paper.

Commodore Nicolaus Johnsen.

THOSE who have travelled on the North German Lloyd liner "Europa" will learn with regret of the death of her captain, Commodore Johnsen, who was operated on at sea and subsequently died in New York on Wednesday of last week. Captain Johnsen was one of the two German members of the Southampton Master Mariners Club, an honour which he greatly esteemed. He started his career in German sailing ships, but later served for nearly twelve years on British sailing ships, afterwards joining the Norddeutscher Lloyd Company, commanding at one time or another nearly all the vessels of its large fleet. We have heard him record that after the war the company was only left with one small vessel, which he commanded. A year or two later he was appointed captain of the "Columbus," and from that ship he passed to the "Europa." He was paid a high compliment two years ago, when the German Government promoted him to the rank of Commodore. Although he was a stern disciplinarian, he was very human and was loved by his men and always honoured by those who were privileged to travel with him and perhaps spend a few moments with him in his cabin or on the bridge.

The New Metropolitan Railway.

ON Saturday, Dec. 10th, the branch of the Metropolitan Railway from its main line at Wembley Park to Stanmore was put into public service, after being formally opened on the preceding day by Mr. P. J. Pybus, the Minister of Transport. The new line is 4½ miles in length, and double throughout. It has intermediate stations at Kingsbury and Canons Park, and another is to be opened later at Queensbury, which is midway between the two stations just named. The railway has been built under the Developments (Loans, Guarantees and Grants) Act, 1929, and is, of course, electrically operated. There are two new sub-stations—one at the junction with the main line and the other at Canons Park. The most interesting feature is the signalling, in that the terminus at Stanmore is operated on what is known as Centralised Traffic Control. There are five sets of points and seven signals, all of which are actuated from Wembley Park signal-box, 4½ miles away. In that box is an illuminated diagram on which, by means of track circuits, the condition of the lines and connections at Stanmore is repeated. The signalman in Wembley Park watches the diagram, and by means of nine keys—five for points and four for signals—on a panel below the diagram, he causes the roads and signals to be electrically changed as required. This is a development of the long-distance operation of points, which has become so important a feature in securing operating economies by signalling during the last few years, and is the first installation of centralised traffic control in the world outside the United States and Canada. The lines between Wembley Park and Stanmore are protected by automatic signalling of the ordinary type. Mr. Pybus performed the opening ceremony by illuminating the panel at Wembley Park and making the road and clearing the signal at Stanmore for the reception of the special train by which he was travelling.

Air Surveys.

AT a lecture delivered before the Royal Aeronautical Society last Thursday, December 8th, Lieut. J. S. A. Salt, Secretary of the Air Survey Committee, said that if it were assumed that the need for mapping within the Empire was great, there must be the question as to what form of administration could best carry forward any particular policy. The difficulty of operating by contract with a private company lay not so much in the organisation of that company as in the fact that the demand would be intermittent. The only sound organisation would therefore seem to be one drawn up on Imperial lines. Proceeding to expand this scheme, Lieut. Salt suggested that a central map-drawing and reproduction department should be served by specially constructed aircraft, capable of flying to various parts of the Empire to make the surveys under the best weather conditions. The cost, he said, would certainly be comparable with that of an ordinary ground survey, but probably cheaper, while there would be a great saving of time. A survey which normally might take between ten and fifteen years, could be carried out in two or three, while the photographs obtained would form the basis for geological, ecological, forestry and other surveys. During the discussion following the lecture, Mr. H. Heming, formerly managing director of the Aircraft Operating Company, revealed that certain proposals at present under consideration by various Government Departments embodied a project for the establishment of an organisation such as that mentioned.

Emptying a Lake.

ALTHOUGH the reclamation of land by slow drainage has been practised for centuries, examples of the rapid emptying of lakes and similar bodies of water must be rare indeed. Great interest attaches, therefore, to a work of the kind which was brought to a successful completion by Italian engineers on Sunday last. The lake in question is, or was, the Arsa, in Eastern Istria, near the coast, almost half-way on a straight line drawn between Pola and Fiume. It was a small body of water some 2½ miles long by about half that in width, but into it a large surrounding area of bog land emptied itself. To drain and reclaim the land the obvious but daring plan of driving a tunnel into the lake and letting the waters run into the Gulf of Quarnero was conceived and has now been successfully achieved. The tunnel is nearly 3 miles long and goes through Mount Chersano, which stands between Lake Arsa and the sea. From the outer end of the tunnel a canal about a mile long has been cut. On Sunday last the plug of rock which still held the waters of the lake back from the tunnel was blown up by the explosion of twenty-four mines, and the lake immediately began to discharge itself into the Gulf of Quarnero and so into the Adriatic. It is estimated that nearly 3000 acres of land will be redeemed by this work and be rendered fit for cultivation. The work has taken four years to complete.

Salving the M 2.

WE regret to have to record the failure on Wednesday afternoon, December 7th, of the third attempt to raise the sunken submarine "M 2." Four lifting pontoons, two at the bow and two at the stern, had been attached to the hull by chains, and after three hours' operation of the air compressors on the diving ship "Tedworth," the bow end left the bottom and subsequently came to the surface. In the late afternoon, however, the stern pontoons suddenly broke water, and the stern end rose to the surface, the bow simultaneously sinking until the hull remained suspended from the stern end in a steeply inclined position. All efforts to raise the bow end again failed, and it was finally decided to allow the submarine to sink to the bottom again, and to remove the lifting pontoons. On Friday, December 9th, the Board of Admiralty issued an official statement to the Rear-Admiral Submarines and all other naval ratings concerned, recording its decision to abandon finally all salvage operations. That statement records the appreciation of the Admiralty of the magnificent work done during the last ten months by the divers and all concerned with the salvage operations, which have been carried out under numerous difficulties of weather, sea depth and tide. Although, the statement continues, the conclusion comes as a bitter disappointment to all who have given such skill and such courageous and persistent devotion to it, the experience gained has fully justified the operations, which reflect great credit on all those concerned.

Low Temperature Carbonisation.

SPEAKING at the annual meeting of Low Temperature Carbonisation, Ltd., held at Winchester House on Tuesday last, Colonel W. A. Bristow said that on December 5th the company despatched to an Admiralty depôt the first bulk of oil fuel from British coal. To the best of his knowledge, that was the first occasion in history on which a warship had proceeded to sea fuelled only by oil produced from its national coal. After visualising a time when the fate of the British Empire might depend on an oil pipe line in a hostile country, Colonel Bristow said that the very existence of the mining industry was being seriously threatened in its foundations by the ever-growing menace of imported oil. The British Navy, Air Force, and to a large extent the Army also could only move when supplied with large quantities of oil. The Low Temperature Carbonisation Company had produced a petrol from coal which, under official tests, had proved to possess anti-knock properties about 30 per cent. better than any other petrol. Its use enhanced the performance of any high-compression engine, such as used in aircraft, and preliminary steps were being taken to establish in this country a commercial plant for the conversion of coal oil into motor spirit.

The Hoover Dam on the Colorado River.

No. II. *(conclusion).**

IT was apparent to the contractor that some other method of driving the so-called bench heading was desirable, and it was equally evident that a standardised equipment should be devised to assist in doing the work. The aim was to produce a drill rig or carriage of some sort that would render it possible to drive the bench headings without recourse to ring-drilling or the use of down holes. Inasmuch as the spoil was to be transported by trucks, and the loading was to be done by Marion electric shovels fitted with 3½ cubic yard dippers, it was essential that the drill carriage and a shovel should be able to pass one another in the tunnel. After some experimenting, a drill carriage or "jumbo" was designed that could drill one half of a bench at a single set-up.

The jumbo—Figs. 8 and 10—consisted in the main of a steel framework arranged to support plank platforms at four levels, the stanchions at the four corners of the framework extending below the lowermost platform and ending just above the ground when the whole rig was placed upon the chassis of a 10-ton International truck. The drill runners worked from two of the platforms, while the two shorter platforms were used for racks or floors on which to place the drill steels conveniently to each drilling position. The drills were carried on quarry bars and columns of heavy pipe which permitted the drilling of holes at the desired angles. All told, drilling could be done from five horizontal positions—the lowest position being beneath the bottom platform, with the drill runners working from the ground. Thirty-two Ingersoll-Rand drifters were mounted on the carriage. The drilling was done wet, and both water and air connections were made with lengths of hose extending from the carriage to a 6in. air line and a 2in. water line laid on the floor of the tunnel and usually terminating within about 100ft. of the heading.

Each drifter could be moved laterally on its bar over a range of 8ft. This movement provided ample flexibility to drill all the holes in each position of the carriage. The drillers at the top working platform were protected from falling rock by a sturdy sheet metal apron. The trucks carrying the jumbos had wheel bases of 210in. To place a carriage in its working position the truck backed up against the tunnel face at one or the other side of the heading; screw-jacks were then used under the four corner legs to block the carriage firmly. So secured, and with air and water connections made, drilling could be started. With virtually all the drills in action, the stiffness of the carriage was such that vibration gave no trouble. A total of forty-eight holes was drilled in each half of the face of the bench heading. The holes were driven to depths of as much as 20ft.—23ft. steels being used. The two rows of holes at the top of a bench round were drilled upward toward the floor of the top heading and the wing sections flanking that heading. When half of the face of the bench heading had been drilled, the jacks were released at the corners of the carriage and the truck pulled away far enough to enable it to back into position at the other half of the face, when the procedure previously described was repeated and drilling resumed. The time consumed in making the shift and getting ready to drill again varied from ten to twenty minutes, depending upon circumstances and the expertness of the men. The time taken to drill a bench heading varied, but the average was about four hours, and the average advance at each firing was approximately 16ft. The time occupied in removing the spoil was a little less than seven hours per round in the majority of cases.

The loading of the holes with the explosive followed immediately after the drilling. Dynamite of 40 per cent. strength was used, and about 1800 lb. was required for each bench-heading round. When the drilling and loading were completed, the men and machinery were withdrawn to a safe distance, and the round was fired electrically in fifteen delays. While the bench heading was being cleared of spoil, the wings above that heading, at each side of the 12ft. by 12ft. top heading were drilled. This work was done from two vertical bars, fifteen holes being drilled for the purpose in each wing. The wings were drilled and blasted to an average depth of 25ft. in advance of the bench heading. This procedure induced better breaking when the enlarged faced was fired. During January of the current year, 41ft. by 56ft. sections, having a combined length of 6848ft., were excavated in the diversion tunnels—that is, 454,335 cubic yards of rock were removed. In one day, in three shifts on January 20th, 256 linear feet were excavated and 17,000 cubic yards of rock were broken.

When fully equipped, each jumbo carried into a tunnel twenty-five sets of drill steels, about 5½ tons. The number of pieces in each set varied from six to nine, and was determined by the length of the starting steels. All the drill steel used was hollow, round, and of 1¼in. diameter. The rock had a tendency to break on a sharp slope from the top downward, and therefore it was found desirable to use starters from 10ft. to 12ft. long in the top holes. All the steels were conditioned on pneumatic sharpeners, no fewer than thirty of which were provided for the tunnel driving operations. At the beginning of the excavation of the wings above the bench heading, the spoil was removed by hand, but later a caterpillar tractor was placed in the top heading. It was equipped with a bulldozer, and shoved the spoil over the lip of the main heading so that it would fall on to the floor of the tunnel within easy reach of the shovel. The work of the big Marion shovels—one at each heading

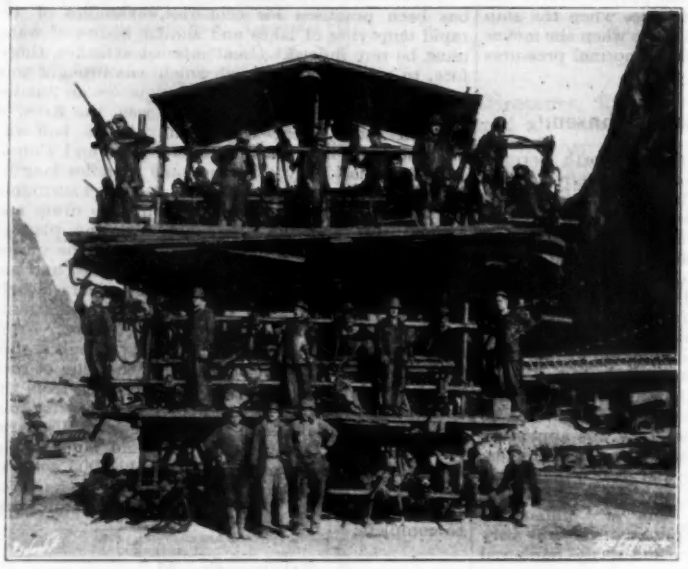

FIG. 8—ONE OF THE DRILLING "JUMBOS"

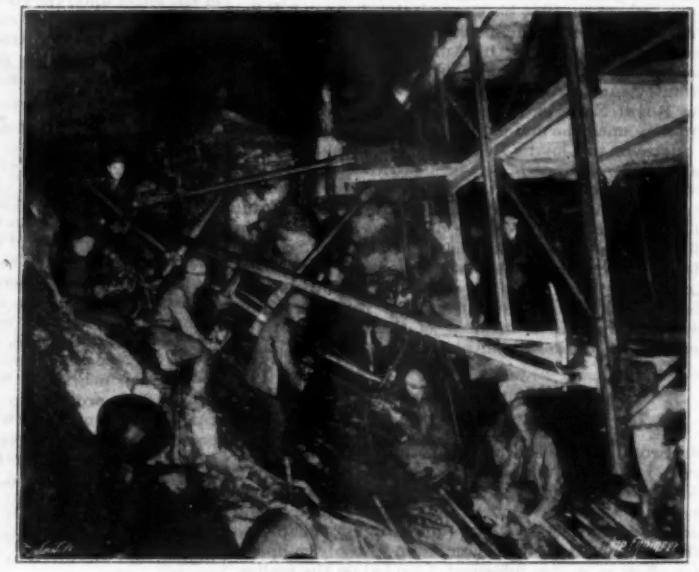

FIG. 9—"JUMBO" WITH FOLDING WING FOR DRILLING INVERT

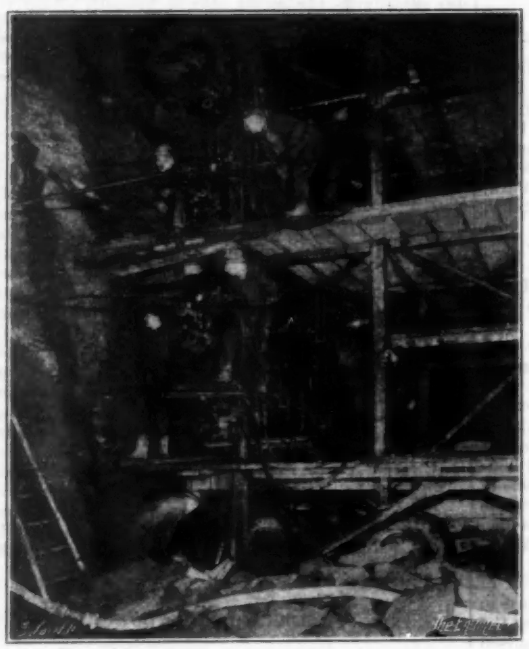

FIG. 10—DRILLING "JUMBO" IN POSITION

FIG. 11—TRIMMING "JUMBO"

* No. I. appeared December 9th.

—was aided by caterpillar tractors, each of 60 horsepower, equipped with a bulldozer in front and a cowdozer at the rear. The function of these caterpillar tractors was to clear the tunnel floor by concentrating the spoil so that the shovel could advance to its job and attack the pile made ready for it. The cowdozer scraped the spoil from the foot of the bench and helped to keep the tunnel floor properly aligned. As has been stated previously, the 3½ cubic yard shovels loaded motor trucks that hauled the spoil to points where damping was permitted. This work presented difficulties because Six Companies Incorporated was not allowed to dispose of any of the waste material by dropping it into the river. Therefore, it had, at some points, to be hauled up steep roads cut in the face of the canyon, and at one point a tunnel 400ft. in length had to be driven to facilitate the movement of the trucks. In general, the spoil had to be transported anything from 1 mile to 2 miles for disposal.

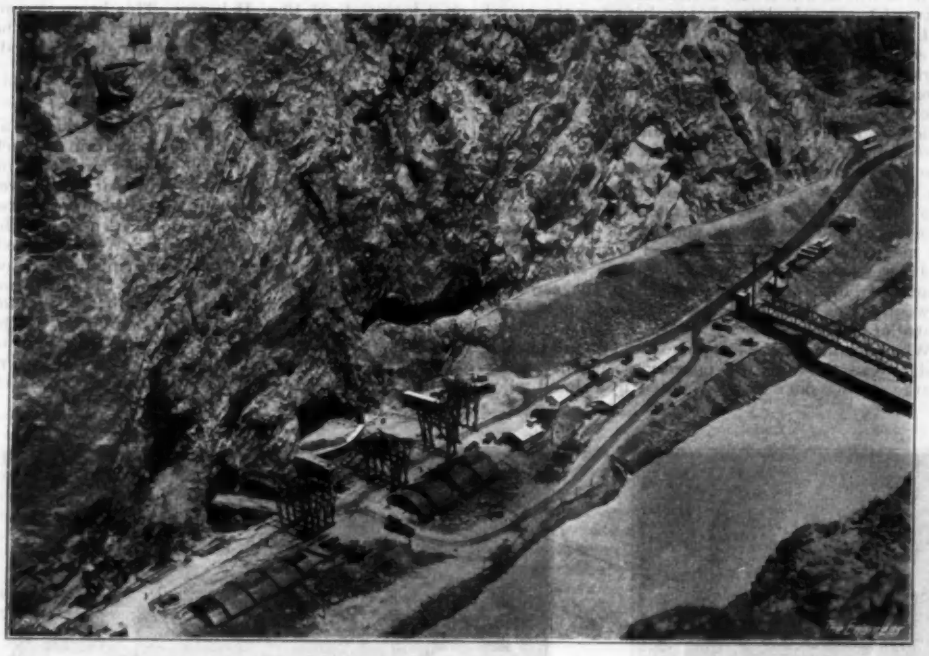

FIG. 12—INTAKE PORTALS ON NEVADA SIDE OF BLACK CANYON

FIG. 13—RECEIVING CONCRETE AT TUNNEL PORTAL

WATER AND AIR.

From end to end of the tunnels—the last of which was holed through on May 23rd, 1932, a year and nine days from the date of starting—no major faults were encountered, and the rock has shown no tendency towards spalling or air-slacking. No heavy ground was encountered, and no timbering was required at any point. Water gave well-nigh negligible concern, and the small amounts that seeped into the tunnels were readily controlled by motor pumps that have stood up remarkably well when dealing with water that was often little less than fluid mud. Notwithstanding the exceptionally rapid rate at which the diversion tunnels have been driven, the overbreak has been comparatively small, a result attributable to the nature of the rock and the careful spacing of the drill holes.

Blowers of capacities ranging between 34,000 and 120,000 cubic feet a minute served to ventilate the adits and the top headings. The blowers moved the air through 18in. pipes at a rate of 8000 cubic feet per minute. There was a natural flow of air at a velocity of 1ft. to 2ft. per second from the portal of a tunnel toward the face at the bottom of the tunnel, and a reverse movement in the upper half of the tunnel. These air streams were caused by the differences in temperature inside and outside the tunnels. The blowers served to accelerate this natural movement. It was found quite safe to resume operations at a heading within ten minutes after a blast.

EXCAVATING THE INVERT.

The invert section of each diversion tunnel was drilled by adapting the jumbo for the purpose—see Fig. 9. Each drill carriage, with its top removed, was equipped with a folding wing on each side that gave the desired spread, and a curved bar, partly sustained by these wings, was modelled on a 28ft. radius. This bar was rigid enough to carry eight drifters, and above them, on a short and straight horizontal bar, four other drifters were mounted. The equipment served to drill the entire invert face at one operation, the holes being 20ft. deep and twenty-five in number. Approximately 750 lb. of 40 per cent. dynamite were used for each round, and an average of 320 cubic yards of rock was thus broken.

The trimming and scaling of a tunnel were carried on while the invert was being excavated. The trimming jumbo—Fig. 11—consisted of two parallel steel trusses, each shaped to the periphery of about a 35ft. section of a 50ft. diameter circle, which were placed about 9ft. apart and connected by a steel framework. The structure was mounted on car wheels and propelled on parallel rails, located for line and gradient with respect to the tunnel by Government engineers. A triangular plate, having at its centre of gravity a small ring or other contrivance for fastening a steel tape, was affixed to the jumbo by three cables, each equipped with turnbuckles and so arranged that the plate was held near the centre line of the tunnel. When the jumbo was set up, Government engineers adjusted the plate so that the ring was accurately placed at the tunnel centre line, and workers, operating from the timber platforms, took measurements with a steel tape from the ring to the tunnel roof and the walls to determine which projections should be removed. These projections were barred down or blasted loose. Trimming of the invert was done immediately in advance of the tunnel lining operations. Skips were loaded by hand or power shovel and were transported to the dumping ground directly by truck, or, where necessary, first by a gantry crane, installed for concreting operations, and thence by truck.

FIG. 14—GANTRY CRANE PLACING CONCRETE LINING OF INVERT

Great credit is due to the engineering *personnel* of Six Companies Incorporated for the skill and resourcefulness displayed in driving the four tunnels within a space of one year and nine days, during which labour troubles stopped work for a week, while in addition, an unexpected rise of the Colorado in February of the current year arrested operations for ten days, the flood waters overtopping embankments and carrying much mud and refuse into the upstream portals. A crew averaging eighty men was employed at each main bench heading. The drilling jumbo crew was made up of twenty-two miners, twenty-one chuck tenders, five nippers, one safety miner, and one drill foreman. Two crews, each of fifteen men, were employed in drilling the wings on the sides of the 12ft. by 12ft. top heading. A mucking crew was composed of a shovel operator, one oiler and one pitman. In addition to the foregoing workers, there were electricians, pumpmen, powermen, and superintendents who were engaged intermittently at several headings. The following daily wages were paid:—Miners, 5·60 dollars; chuck tenders and nippers, 5 dollars; oilers and pitmen, 5 dollars; shovel operators, 10 dollars.

EQUIPMENT.

Compressed air for driving the rock drills, operating the drill steel sharpeners, and for furnishing motive power to some other apparatus in connection with the work on the four diversion tunnels, was supplied by three interconnected compressor plants. Plant No. 1 is situated on the west side of the river some distance above the intake portals of the two diversion tunnels on the Nevada side. That plant has a combined capacity of 4080 cubic feet per minute. Plant No. 2 is on the Arizona side of the river close to the

dam site, and has a capacity of nearly 3950 cubic feet per minute. Plant No. 3 is close to the outlet portals of the Nevada tunnels, and has a capacity of 8172 cubic feet per minute. The distance between plant No. 1 and plant No. 3 is quite 2 miles. The plants are interlinked by a system of 6in. lines with 3in. and 4in. branches, and the distributing conduits cross the Colorado at four points on suspension bridges. The compressors are driven by Westinghouse synchronous motors with belted exciters.

The concrete mixing plant is in Black Canyon, on the Nevada side of the river, somewhat less than a mile upstream from the dam site, and at the base of the towering canyon wall. This plant has a computed capacity of 6600 cubic yards per twenty-four hours. The concrete walls of the diversion tunnels are not less than 3ft. in thickness, giving the tunnels a finished internal diameter of 50ft. The work of lining the tunnels is unusual, because of the size of the tunnels, the design of the forms used, and the amounts of concrete to be placed. The intake portals —see Fig. 12—are protected from flood waters by concrete arch cofferdams, and these cofferdams are supported on their river faces by rock fills. Because of these obstructions trucks cannot be used to deliver concrete directly into the tunnels at these portals. Therefore, as illustrated in Fig. 13, the concrete is carried from the mixing plant to the inlet portals in agitator drums of 4 cubic yard capacity, and there dumped into a chute leading to a steel hopper, from which it is discharged into steel buckets as desired. These buckets, two of which are loaded on each 10-ton truck, are moved to the pouring site, where a 10-ton gantry crane—see Fig. 14—picks up the buckets and transports them from the truck to the pouring position.

Tunnel Lining.

The tunnels are being lined each in three operations—first, the invert section, embracing the lower 74 deg. of the tunnel; next, the side walls, consisting of 88 deg. on each side; and last, the remaining 110 deg. of the crown or roof. All sections are poured for the same length, namely, 40ft., except in those portions of the two tunnels—one on each side of the river—which will be used for spillway purposes. In those spillway tunnels the construction joints are 26ft. 8in. apart. With a tunnel cleaned for lining, the first preparatory step was the pouring of parallel rail bases for the gantry. These two foundations were 3·1ft. above the finished tunnel invert, care being taken to have the facing sides of the foundations poured accurately to line and gradient, with each foundation 15ft. 9½in. from the centre line of the tunnel. Each of these foundations has an average width of 30in., topped with a 6in. by 12in. timber to which the tracks of 90 lb. rails are spiked. A 10-ton gantry crane runs on these rails, and is capable of moving at a maximum speed of 300ft. per minute. The transverse traveller of the crane operated by a 10 H.P. electric motor, is equipped with two hooks, each of which can handle a 5-ton load. The traveller has a hoisting speed of 100ft. per minute, and a transverse speed of 125ft. per minute. The crane can carry two buckets, filled with concrete, at one time.

Longitudinal steel side forms, 2ft. high, made up in 10ft. sections, are set in position on the rail foundations and held firmly in place by means of bolts secured both to the concrete bases and to the timber beneath the tracks. Transverse steel forms 2ft. wide and about 32ft. long, spaced either 26ft. 8in. or 40ft. apart, are next bolted to the longitudinal forms, and braced against the rock floor of the tunnel. The space between the form and the floor is filled with a 2in. timber bulkhead. The transverse and longitudinal forms are made up of 10-gauge steel plate, smooth inside, supported by 2in. angle top flanges and 2in. by 3in. stiffeners. Keyways are formed between the abutting sections, 1½in. by 10in. in the transverse forms and 6in. by 12in. in the longitudinal forms, and consist of grooves in the steel plates of the dimensions cited.

To give the invert section its prescribed surface, two steel screeds are used. These screeds are equipped with car wheels which run on the inside bottom flanges of two I-beams, the latter being shaped to the invert and separated by an approximate distance of 11ft. At each end the beams are connected by a steel framework which is supported by car wheels which travel upon the upper flanges of the longitudinal forms. Each screed has a deck mounted on the screed plate, which itself is shaped to the radius of curvature of the finished tunnel section—that is, 50ft. in diameter. The screed plate is about 11ft. long and 4ft. wide. On the deck is mounted a hand winch that operates two cables, each of which is fastened through single sheaves to the framework connecting the I-beams. By means of the winch the screed is moved upward and across the invert toward the side forms. For concreting operations, the winch on the screed is unwound so as to cause the two screeds to meet at the centre of the tunnel.

When a gantry crane has picked up two full buckets and moved them to the pouring position, the discharge of the concrete is regulated by a hand wheel control of the bucket gate. The concrete is dumped on the tunnel wall side of each screed and then puddled into place. When the space in the form is filled, the screeds are drawn toward the sides of the tunnel, moulding the lining of the invert in the process. Screw jacks on the axles of the track framework are used to raise the framework so that it and the screeds can be shoved by hand forward to the next pouring position. If the distance, however, be considerable, the gantry crane picks up the apparatus, and shifts it to the desired situation. The surface of the invert is finished by workers using a movable timber platform that is supported, just above the concrete, by curved I-beams placed 5ft. apart. The beams are tied together at their ends by a steel framework, fitted with double-flanged wheels that travel on the crane track. When the concrete has been finished in the invert, sand, to a depth of about 3ft. on the centre line of the tunnel, is placed over the concrete to serve as a roadway for trucks.

With the lining of the invert poured far enough to permit the beginning of the side wall lining, the next preparatory step has consisted of forming a concrete shelf 18in. wide at each side of the tunnel on the finished invert. Upon these shelves 90 lb. rails were laid, 11½ft. from the centre line on each side. The side wall jumbo travels on this track. The jumbo—see Fig. 15—is a structural steel framework, 80ft. long and about 50ft. high, built of structural steel, and weighing 385 tons. This framework supports the ¼in. steel plating of the wall forms. The jumbo has chutes, a travelling crane, and other apparati for placing the concrete in position. It also has a series of screw jacks and ratchets to control the distribution of the hydrostatic pressure of "green" concrete, and to adjust the positions of the wall forms for pouring, or to shift the jumbo to a new station. The jumbo is made up of five panels, three of 20ft. and two of 10ft. in length, so as to accommodate unequal wall length on curves. Each section is equipped as a unit with its own double-flanged wheels and chutes. Screw jacks and ratchets are carried on top of a section and can be made to bear against the rock crown to resist the upward pressure of green concrete. Additional jacks, placed at the ends of the horizontal struts connecting the forms on each side of the tunnel, bear against the arch beams that hold the face of the steel form. On curves, wooden gores have been used to fill the space between the steel sections. A bridge crane of 5-ton capacity, equipped with a 10 H.P. motor, and provided with two bucket hooks, runs on a pair of 50 lb. rails which are carried on a longitudinal 10in. H beam. This beam is supported by the vertical struts of each panel. The bridge and the transverse traveller have speeds similar to those of the invert concrete gantry.

Pouring the Sides and Crown.

In pouring the side wall forms the procedure is as follows:—A 2-yard bucket is hoisted from a truck driven to the section and is moved so that hooks on its gate are above a 3in. round tripping bar placed over the chute. The bucket when slightly lowered after its hooks have engaged the bar, opens its gate and the concrete is discharged into the chute. When emptied, the bucket is disengaged from the tripping bar and lowered on to the waiting truck and at the same time the second bucket on the truck is lifted and discharged into a chute on the opposite side of the jumbo. From five to seven workmen, in charge of an inspector, are stationed behind each form to puddle the concrete into place. A timber bulkhead, framed to provide a 1½in. by 10in. keyway, is placed at the centre or one-third point of an 80ft. length of forms, and each of these 40ft. or 26⅔ft. sections is poured to the top of the form before the adjacent section is started. About thirty-four hours are required for the pouring of an 80-ft. section of wall on each side of the tunnel, and the forms remain in place for a further period of twelve hours. When the jacks and ratchets are loosened, the form is moved to a new position, the jumbo being drawn forward by block and tackle attached to the rails ahead and actuated by air winches carried on the jumbo. All told, the pouring of the side walls of an 80ft. section represents a cycle of approximately sixty hours.

The crown sections of the diversion tunnels are being poured by means of still another type of structural steel jumbo, which is equipped with a concrete gun carriage, a pipe carriage, a traveller, and an arch-form support. This assemblage—see Fig. 16—is moved on flanged wheels which run on the 90 lb. rails previously used by the side wall jumbo. The gun carriage, about 45ft. long and 47ft. high, is equipped with two pneumatic concrete guns, together with their receiving hoppers and concrete conveyors of 8in. wrought iron and rubber hose. There is also a two-drum electric hoist. The gun carriage is moved on its tracks by a 25 H.P. motor, and its speed forward is 100ft. per minute with a reverse movement of 20ft. per minute. The buckets of concrete are handled by a hoist actuated by a 50 H.P. motor, and the lifting speed is 300ft. per minute. The pipe carriage and traveller support the 8in. pipe by which the concrete is discharged into the space above the crown forms.

The arch-form jumbo is made up of 10ft. and 20ft. panels, each of which is of structural steel, and provided with jacks to place the face of the form in correct position for pouring or to retract it at the proper time from the set concrete. The central 88 deg. of the crown section is supported by trusses spaced at a

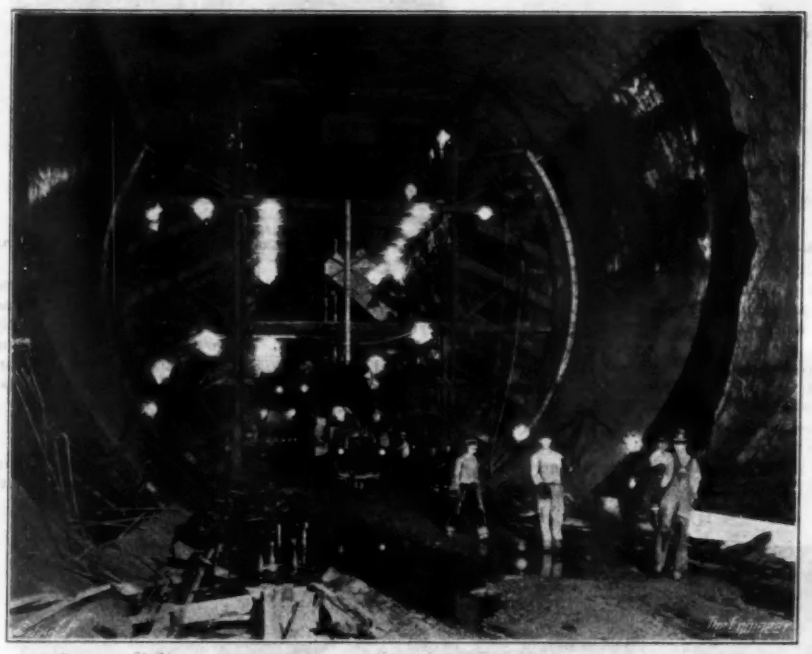

FIG. 15—"JUMBO" FOR CONCRETING SIDE WALLS

FIG. 16—"JUMBO" FOR CONCRETING CROWN SECTION

maximum interval of 7ft. 4in., and having lower chords 33ft. 4in. long. The form face, with its supporting beams, for the lower 11 deg. on each side of the centre is connected at one end to the truss and supported at its opposite and exterior end by screw jacks bearing on the framework of the jumbo. Bulkheads are placed wherever necessary to secure transverse construction joints in a manner similar to that followed for the joints in the invert and side-wall sections.

When everything is ready for pouring, the electric hoist on the gun carriage lifts a 2-yard bucket from the truck and empties the concrete into the gun hopper. The pneumatic gun forces the concrete through the distributing 8in. pipe and delivers it to the centre of the arch form. From that point the concrete flows to its final position through a 90 deg. elbow and continuation of the conveyor pipe, or by a chute and baffle arrangement extending down the arch form. Pouring is started at the end of the form farthest away from the gun; and the conveyor pipe and its appurtenant placing equipment are moved lengthwise on the forms as the concreting progresses.

All concrete in the tunnels is sprayed as soon as the forms are removed, and the exposed surfaces are continuously wetted for fourteen days thereafter. Perforated pipes are provided for this service, the necessary water being drawn from sumps dug for the purpose near the tunnel portals where comparatively clear water is obtainable.

According to the last available report—that covering activities up to October 8th—the work of lining the four diversion tunnels had reached the following stages of completion:—Invert, 83 per cent.; side walls, 73 per cent.; and arch, 57 per cent. The average number of officials and workmen engaged on the project at the end of September was 4315. Of that number, 240 belonged to the *personnel* of the Bureau of Reclamation. Work on the upstream cofferdam was started in September. Pouring of concrete in the main dam is scheduled to be begun June 1st, 1933.

In subsequent issues other phases of this stupendous undertaking will be dealt with, when the work has gone forward far enough to warrant further description.

Statistics and Engineering.

By DUDLEY W. WALTON, F.S.S.

No. II.*

A FUNDAMENTAL concept of statistics is the average. This is a computed value which describes a group of measurements, or enables the differences between one group and another to be recorded as a single figure.

Averages are of several kinds. Everyone is familiar with the average which is the sum of the values of the observations divided by their number. This is known as the arithmetical average or mean. Thus, the mean weight of a collection of bolts, each reputedly weighing 16 oz., may be 15·078 oz., and this mean figure implies that individual bolts of the consignment are below the specification. There is probably no one bolt which corresponds to the mean. Half the consignment may be approximately 18 oz. each, and the other half 14 oz. Or 99 per cent. might be true weight and only 1 per cent. of the bolts deficient. The mean is, therefore, not a complete picture of the general conditions.

Another kind of average is known as the median. This is the middle value when all the samples are sorted out in order of size, or, as statisticians say, "arrayed in order of magnitude." The median has the advantage of measuring the value of a real object, but it does not tell us much about the larger and smaller values at the ends of the row. The middle value might be exactly 16 oz., and yet the bolts might vary all the way from 2 oz. to 32 oz.

A third kind of average is called the mode, or the most common value. If half the consignment of bolts weighed around 15 oz. and the remainder had sundry plus and minus values, the mode would tell us more than the mean. Homogeneity is indicated when there is a close approximation between the mean, the median, and the mode; and also indicated when the median is not far from the quartiles—these are the values midway between the median and the ends of the array. What is known as "the inter-quartile range" defines this difference.

To illustrate the statistical treatment of averages suppose, for example, the miles per gallon recorded with respect to sixteen motor vehicles are as follows:—

Sample.	Mileage.	Sample.	Mileage.
1	27·5	9	29·1
2	30·6	10	29·2
3	31·1	11	29·3
4	29·6	12	30·3
5	28·9	13	30·0
6	28·0	14	29·3
7	30·9	15	29·8
8	30·4	16	28·3

A non-statistical clerk, told to make a graph of these figures, might produce the chart as in Fig. 1, and it would be seen at a glance that most of the values fall between 29 and 31 miles per gallon. A dotted line M drawn at 29·5 would have eight items above and eight below, and 29·5 m.p.g. could be taken as an assumed mean by inspection. The arithmetical average is 29·5187 m.p.g., and accordingly, 29·5 might be made the basis of a bonus to drivers. But the figure would not tell much about the performance of the cars. Let us next array the values in order of magnitude, best done in the form shown in Fig. 2. This method is better than trying to make a smooth, continuous curve, because the quantities are discrete, and intermediate values, determined by interpolation, are not possible. With our even number of samples there are two middle values To select either would introduce bias. When, for convenience, a biassed value is accepted, the less favourable figure should be taken. It is usual, however, with two middle values which differ, to take the mean of the two. This gives 29·45 as the median, so that the line M in Fig. 1 is a little too high to represent it. Let us now find the mode or most common value. There are two cases of 29·3 m.p.g. These represent only 12½ per cent. of the cars, so that in this example the mode is not a very satisfactory measure, seeing how many other items differ by only 0·1. However, so far we have:

Mean	29·518
Median	29·45
Mode	29·3

These are sufficiently near each other to indicate some degree of homogeneity and the data are acceptable for further analysis.

If the data are next examined for what is known as "frequency distribution," we sort out the cars by "class intervals." The determination of the class interval must necessarily be experimental. Let us take an interval of 0·5 m.p.g. and classify as follows:

M.P.G.	No. of cars in group.
27·5–27·9	1
28·0–28·4	2
28·5–28·9	1
29·0–29·4	4
29·5–29·9	2
30·0–30·4	3
30·5–30·9	2
31·0–31·4	1

It is seen that 25 per cent. of the cars are in the class interval 29·0–29·4 m.p.g. If we enlarge the interval and classify by even mileage, we have:

M.P.G.	No. of cars in group.
27·5–28·4	3
28·5–29·4	5
29·5–30·4	5
30·5–31·4	3

There is a symmetrical uniformity in this arrangement which will at once suggest to the engineering mind that some "law" of performance might be formulated. Three of the cars are obviously giving poor service. A driver's bonus might effect improvement, but it seems unlikely that the three worst cars would ever equal the three best.

The question now arises: What is the probability that the calculations from the data are sufficiently acceptable for coming to a judgment without getting new data? Would, for example, another fleet of similar cars behave in the same general way? The question brings up the statistical concept of deviation or a method of measuring the probable error of the samples. Let us arrange the data thus, in skeleton form to save space:

a Original m.p.g.	*b* Mean.	*c* Deviation (*a* − *b*).	*d* Deviation squared (c^2).
27·5	29·5	−2	4·00
28·0	29·5	−1·5	2·25
.	.	.	.
.	.	.	.
31·1	29·5	+1·6	2·56
		Total.. ..	(*d*) 15·91

The total (*d*) of the squared deviations from the mean is then divided by the number of samples, and the square root of the quotient extracted. The result is known as the standard deviation, sometimes called the "root mean square," and commonly denoted by the Greek letter σ, the formula being $\sigma_x = \sqrt{\frac{\Sigma x^2}{n}}$. The working out, for which the slide rule suffices, is $\sqrt{\frac{15·91}{16}} = 0·995$. This is so near to a standard deviation of 1 m.p.g. that it will simplify the remaining discussion to use the rounded figure. We proceed to add and to subtract this s.d. to and from the mean figure of 29·5 and establish a range of 28·5 to 30·5. We can place within one s.d. of the mean no less than ten of the sixteen cars, or 62½ per cent. If we take twice the standard deviation (a process akin to that of the engineer who doubles his factor of safety) the range becomes 27·5 to 31·5, and the whole of the sixteen samples come within the range of two s.d. It is possible now to test, by a simple statistical method, how near our original sample values are to an idealised set of average performances. Tables are available to determine the probability that a computed average lies farther from the true value than a stated number of times the standard deviation. In the case of sixteen samples and one s.d. the tabulated figure is 0·3332, and for two s.d., 0·0640. That is to say, on the general theory of probability, there are 333 chances to 1000 that our computed range of 28·5–30·5 does include the true average of the whole universe of similar cars, and 64 chances to 1000 that the true value lies between 27·5 and 31·5.

It is now established that if we purchase sixteen new cars and operate them on the same conditions as the old, their average performance would not vary more than 2 m.p.g. from the old average, with the probable risk of 64 per 1000 not conforming to the average. This probability includes the prospect of both better and worse, and there is an equal chance that if one new car was as low as 27·5, another might

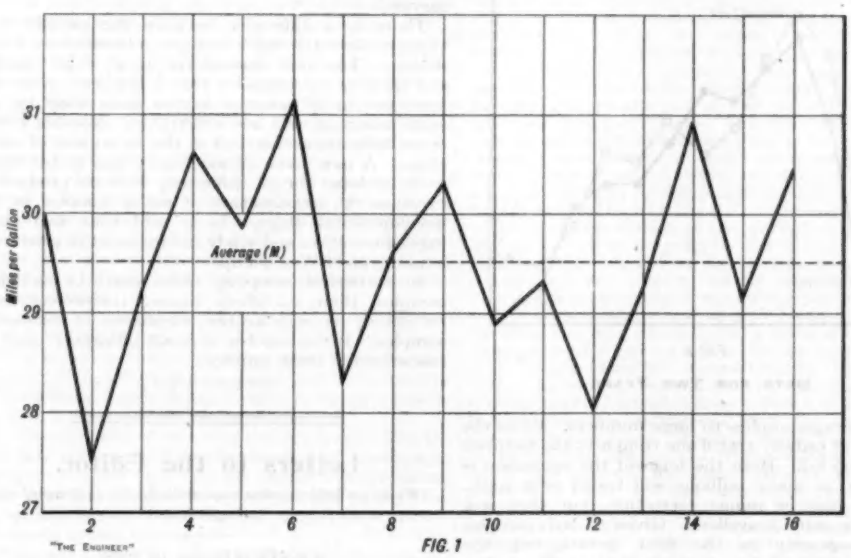

FIG. 1

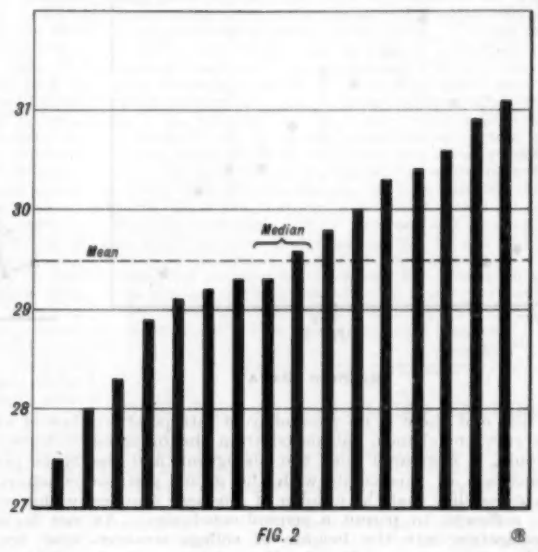

FIG. 2

MILES PER GALLON OF SIXTEEN MOTOR CARS

* No. I. appeared December 9th.

be as high as 31·5. A minimum of thirty samples is desirable in order to judge the character of the population from which they are drawn. If, in the present discussion, there had been thirty cars with the same average performance, the chance of a new fleet being within one s.d. is calculated from the tables at 317 per 1000, and within two s.d. at 45 per 1000. The chance of a different figure being experienced within the range of three s.d. is only 27 per 1000. Statisticians are usually satisfied, when they have thirty samples, that the true average of a universe will vary by not more than three s.d.

The standard deviation is of no use in estimating the reliability of samples known to be biassed, but with such figures as those now under discussion the s.d. provides a reasonable measure. One could, as a consequence of this statistical analysis, fix a driver's bonus on the basis of 30·5 m.p.g. and conduct an inquest on those cars which ran at less than 28·5 m.p.g.

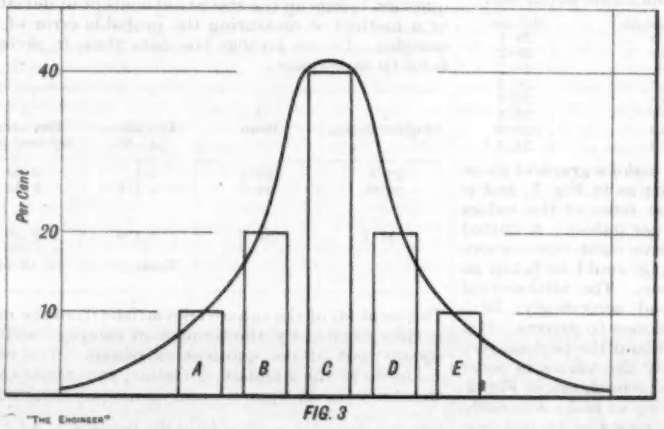

FIG. 3

HISTOGRAM OF UNIVERSITY GRADUATES

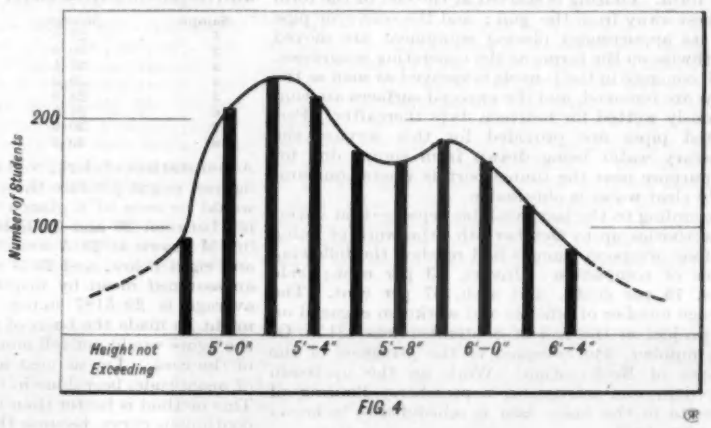

FIG. 4

TYPICAL CAMEL-BACK CURVE

The Reliability of Sample Observations

The behaviour of a fleet of motor vehicles has been statistically analysed on a basis of sixteen observations. Such observations, not covering the whole "universe" of a given class of phenomenon are statistically described as "samples." It is possible to discover whether samples are representative or not. A large number of samples will usually fit a curve of chance. Amongst the graduates of a university, in their post-graduate life, it was found, in round numbers, that there were 10 per cent. failures, 20 per cent. undistinguished scholars, 40 per cent. of normal successes, 20 per cent. of outstanding scholars, and 10 per cent. of brilliant men. These data, to illustrate a type of presentation known as the histogram, are shown in Fig. 3. Histograms are used when quantities are discrete and there is no possibility of interpolation. The curve of chance, calculated from the binomial formula, is compared with the histogram, and the comparison of this curve with the group justifies the probability that the number of graduate samples was sufficient to permit a general conclusion. An investigation into the heights of college students produced the curve in Fig. 4. Here the camel-back curve indicates either that the number of samples was insufficient, or that there were at least two causes behind the maxima. The tentative inference was that the students were drawn from two types of physique, and investigation showed that the second hump was due to a proportion of men from North Britain. When a performance curve takes on the character of Fig. 4, the engineer is apt to discard it because of a wish to smooth out a curve in order to deduce a formula. Such results, however, indicate either the need for more observations, or for further analysis. The Rosenhain recalescence curves are of this type. The peak of otherwise regular phenomena is often displaced from the centre, as in Fig. 5. This does not invalidate a reference to the curve of chance. The inference is that some cause has affected the mode, or most common value, so that it tends not to coincide with the median, or middle value. Seasonal figures often have their peaks displaced, as, for example, in the case of a varying demand for process steam. Annual comparisons can be facilitated by placing peak to peak, as in Fig. 6, and noting the time-relationship on the calendar scale.

For a statistical argument the minimum number of samples should not be less than thirty, or corrections calculated from the standard deviations, as explained in the preceding article, are necessary. The maximum number of samples can be determined as a percentage of the "population." Much experience shows that it need seldom exceed 5 per cent. Results from 5 per cent. samples are often as good as from 10 per cent. and need less tabulation. Many Government inquiries, when the number of cases affected is one million or more, have been on a 1 per cent. basis. One important official report was on the basis of 4·38 samples per thousand. When an odd number of samples is collected it is advisable to use a workable number, say, 500 out of 516, eliminating the odd sixteen by chance drawing. If there should be, say, 200 samples duly arrayed in order of magnitude (as was illustrated in Fig. 2), time can be saved in making a graph by recording alternate values, or in large numbers every fifth sample. When this is done the general character of the curve will not be altered. If a battalion of soldiers is lined up in order of height and they ultimately form fours, the men in each rank will be in the same height relationship.

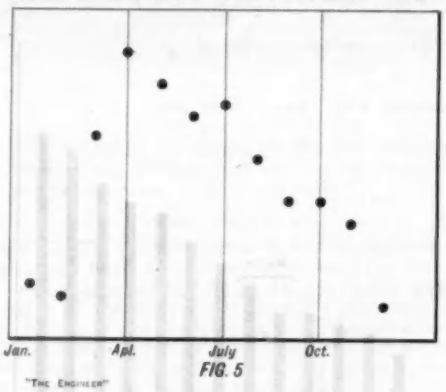

FIG. 5

PERIODIC DATA

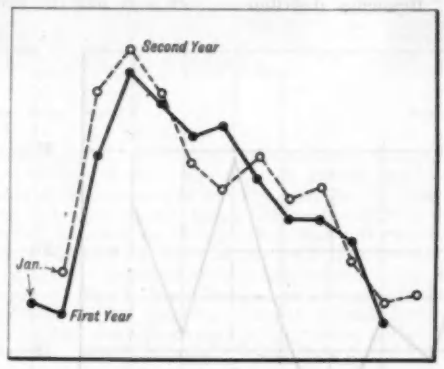

FIG. 6

DATA FOR TWO YEARS

Constancy of Statistical Aggregates.

There is a constancy in the components of an aggregate. This is another way of saying that the law of averages applies to large numbers. From the statistics of railway travel one computes the facilities to be provided. Here the form of the aggregate is constant; so many millions will travel next week, within a plus or minus correction, but they will not be the same travellers. Given enough samples and homegeneity in the field investigated, the minimum demand for many products and services can be determined in advance. In measuring phenomena it should be noted whether the observations refer to a point in time or continue over a period. Railway-passenger statistics are continuous and complete, or so nearly complete that the discrepancies have no significance. Statistics of the sales of a commodity are usually complete. Snapshot figures are of value when continuous observations cannot be made. The census is a snapshot of the whole human population at a selected hour. The ratios of the population are determined absolutely for the census hour, and can be computed for any intervening date. The behaviour of a steam engine checked by indicator diagrams, the output of a machine recorded mechanically, switching in a recording device, testing an electric circuit, &c., are instances of taking samples which provide data capable of statistical analysis and deductive treatment.

Differences between successive sets of samples may, or may not, be significant. If the new variations are well within one standard deviation of the set of previous samples, there will not be any need to change the procedure. If the differences exceed a predetermined value, inquiry should be made for the cause. Two or more sets of variable samples of associated phenomena can be compared with each other. If they vary against each other in some regular way one is said to be a function of the other. The consumption of a certain brand of beer has been found to be a function of the temperature. If the thermometer rises x degrees, the beer sold increases by y barrels. Sometimes an exact computable relationship can be determined. In other cases there is a relationship fixed within limits, large or small, influenced perhaps by a constant and a variable.

Use of Engineering "Samples."

Just as the statistician uses samples drawn from a general population, so the engineer has his samples recording the behaviour of materials. These samples provide a general picture to his mind in the same way that vital statistics give a picture of conditions of public health in a given town.

In work connected with the properties of materials data have been drawn for such a long time from such a wide field that the properties of materials, although derived from samples, are matters of certainty, if not of moral conviction. "Certainty" implies that the contrary proposition is inconceivable. For example, the composition and properties of alloys are recorded, and it is only necessary to test for composition, the properties being present if the percentage is established. Accepting a delivery from a reputable source without testing is a case of taking the new delivery as a fair sample of the maker's service.

There is a difference between the sample of a thing produced *en masse* and, say, a locomotive of new design. The new locomotive is a single sample and there is a probability that a duplicate produced from the same patterns in the same shop by the same workmen will act differently. Notable differences have been observed in the behaviour of sister ships. A new piece of machinery has to be tested as an isolated thing. Efficiency in mass production involves the examination of many samples in the developmentel stage. It is said that five years experimentation and study are involved in producing a new type of Weir pump.

In statistical sampling there must be sufficient samples, their variations among themselves must be noted, as well as the variations of successive samples. If the number is small, allowance must be made for the small number.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

CENTRIFUGAL PUMPS.

SIR,—In the paper on "Centrifugal Pump Characteristics," read by Messrs. T. Y. Sherwell and R. Pennington before the North-Western Branch of the Institution of Mechanical Engineers, and published in your issue of December 2nd, an analysis of the losses in two typical centrifugal pumps is given in tabular form—Fig. 5, page 557. Referring to the multi-stage turbine pump, the hydraulic losses are shown as approximately equally divided between "friction and eddies through impellers" and "shock at impeller exit."

I am sure this is quite wrong. In the first place, no mention is made of friction loss from the flow of water in the diffusers, although here the velocity of flow is far the highest in the pump and the proportion of wetted surface to area of passage also the highest. On the other hand,

the rate of flow in the impeller is usually the lowest in the pump, and as it is very well guided by the vanes it is probably fairly free from eddies.

The authors speak in several places of the shock loss on leaving the impeller, as if it was one of the most important losses, but in the very nature of things it cannot be so, as any water leaving the impeller does so in a tangential direction, which is approximately in the same direction as the diffuser passages, and the sudden pulling up must be converted into pressure, the absence or reduction of which is the measure of the loss. Again, with increased output the velocity in the entrance to the diffusers is increased and the shock loss must therefore get less and less, resulting in a continually increasing head at the outlet, if their theory is correct. Actually, instead the head at the outlet with increased output ultimately disappears. The reason for this is not connected with the shock loss, but is due simply to the increasing fractional loss from the increasing velocity in the passages throughout the pump, and a simple calculation will show that it mainly occurs in the diffusers.

It is nearly thirty years ago since these losses as tabulated by the authors were carefully determined on a typical turbine pump at my instigation and on lines devised by me. The experiments showed what I state above to be correct, and as one of the authors—Mr. Sherwell—was engaged on a part of the work at least I am somewhat surprised he has overlooked them.

The same table shows what an important proportion of the losses is taken up by the disc friction, and I will here point out what I have done on one or two previous occasions, that the principal possibility of improvement in the efficiency of this type of pump lies in the elimination of this loss. It can be done by running the impeller in air or in a vacuum, which is, I think, quite practicable. A rotary vacuum pump of French design works somewhat on these lines, but is not very efficient as a water pump, although effective as a vacuum pump.

To accommodate variation of output the diffuser vanes would need to be pivoted as in the Francis turbine and a preliminary pump to ensure a pressure at the impeller inlet might be necessary. The authors' firm have been notable pioneers in the design and production of the turbine pump, and I commend this idea to their notice in the hope that it will be the foundation of another advance.

Bury, December 7th. F. O. L. CHORLTON.

RICHARD ARKWRIGHT—INVENTOR OF MASS PRODUCTION.

SIR,—Richard Arkwright was born on December 23rd, 200 years ago.

Arkwright, more than any other, laid the foundation of modern industry as we know it, by the mechanisation of the processes of production, with their correct progressive relation from raw material to finished product.

His name is popularly associated with the invention of the water frame, the first spinning machine adopted for power drive and mass production, but his real fame should not rest upon this invention, but rather on the fact that he was the first to fully appreciate the economic principles of machine production in the mass sense.

Industry before his time was largely in the hands of individuals, each process being carried out separately and often in different places, and that almost without, or with but primitive, machinery and operated usually by muscular power.

An outstanding example of Arkwright's conception of machine production was the manufacture of the textile machinery itself. This was developed upon similar lines to that begun in spinning, and was in full operation, and with a completeness little realised, more than the half of a century before the name of Ford was accepted by the world as synonymous with mass production.

Though this basic revolution in the manufacture of machines was going on in Lancashire so long ago, it was almost unknown to the rest of the country. It was later to be translated over to New England to form the basis of the great American development on similar lines, and Arkwright's name as the real inventor has been lost in the passage of time.

Now we are come to the 200th anniversary of the birth of this remarkable man who set free forces which have to-day grown to such a gigantic extent as to become, it would seem, almost unmanageable, and to be recoiling in the greatest degree on the country to which is usually accredited the origin of mass production.

But the industry of his native country is another of the sufferers, not merely from the mechanical creations of his brain but also alas from the intensive individualism that, existing in his day as a powerful accelerating force in development, is, in the changed conditions of to-day, an equally stifling handicap.

What will happen to overcome this is hidden from us; maybe an equally outstanding character like Arkwright will emerge, who, less by remedy and more by the driving energy of his character, will achieve a success, like he did in the past, where others have failed.

December 12th. ALAN CHORLTON.

JUBILEE OF THE OPENING OF THE LAW COURTS.

SIR,—On December 4th, 1882, the new Law Courts, designed by Street, were opened to the public, and as they were lighted throughout with the newly invented Swan electric lamps, 2000 in number, we can claim for the English pioneers, in this case Messrs. Crompton and Co., the credit for the first large installation of electric light.

The generating machinery was designed to be placed in the crypt, and was to consist of a number of D.C. Burgin machines, working in parallel circuit, with a large battery of accumulators. But as the work in the crypt was not then complete, a temporary plant, consisting of a Marshall engine driving six Burgin machines by means of shafting and belts, was placed to the westward of the building, in the space which is now an open court.

As soon as the doors were opened to the public, an enormous crowd surged in; the numbers were then estimated to be in excess of 40,000. Naturally, I felt very anxious, as if any failure of light had occurred there would have been great loss of life. It had been reported that the Fenian No. 1 was present, and had arranged to create a panic by throwing bombs. However, nothing happened, as the police kept their eye on No. 1, whose name, I believe, was Tynan, and the whole of our electric arrangements were satisfactory.

It was undoubtedly the success of this first large installation of electric lighting that justified me in tendering for the work of lighting the theatres at Vienna from a central station. Previous to this time installations had been confined to the lighting of a few private houses, in no case exceeding fifty to sixty 16 candle-power lamps. At that time, no one, not even Edison in America, had attempted to produce an installation approaching the size of the one at the Law Courts.

December 9th. R. E. CROMPTON.

Commemoration in France of the Basic Process.

ON December 5th there took place at Paris an interesting ceremony which was organised by the Société des Ingénieurs Civils de France in commemoration of the fiftieth anniversary of the introduction into France of the basic process of steel making, universally known on the Continent as the Thomas process, so named after its principal inventor. In response to a special invitation from Professor Portevin to the Iron and Steel Institute of Great Britain to send a delegation, Colonel Sir Charles Wright, President, Mr. F. W. Harbord, Past-President, and Mr. G. C. Lloyd, Secretary, attended the celebrations. Before the official proceedings began, Monsieur Albert Lebrun, President of the Republic, received the British delegates in private audience at the Elysée, and extended to them a most cordial and friendly welcome, in the name of the French Republic. The President of the Republic further honoured the proceedings by presiding afterwards at the ceremonial meeting of the Society of Civil Engineers of France, at which addresses were successively presented by Dr. L. Guillet, "History of the Basic Process"; Mr. P. Pierard, "Basic Process in the Converter"; Mr. L. Baclé, "The Basic Process in the Open-hearth"; Mr. E. Mathieu, "The Basic Process in the Electric Furnace"; Mr. L. Croussard, "The Iron Ore District of Lorraine."

Monsieur Portevin said that the meeting was held as a mark of their gratitude for an invention which had produced extraordinary results for metallurgy in general and for French industry in particular. He welcomed the British delegation and expressed the sense of appreciation of French engineers of the work done by British engineers for the advancement of metallurgical science, and he looked forward to a strengthening of the Franco-British co-operation in dealing with the problems of industrial progress. The invention of the basic treatment of phosphoric iron had, he said, stimulated research and given greater prominence to the factors of chemical reactions in metallurgy as a means of reducing the time necessary for operations and of effecting greater economies, and the analytical investigations then begun were preparing the way for further developments. They had, he believed, reached the end of one era initiated by the invention of Sidney Thomas, and were about to enter another, for recent research led them to believe that new processes were possible in which still greater precision, rapidity, and economy would be obtained. Monsieur Portevin concluded by referring to the debt which metallurgists owed to Monsieur Henri Chatelier, who was present.

Professor Léon Guillet, of the Ecole Centrale, gave an historical survey of the progress of steel since the time of Bessemer, and referred to the theories that were propounded in France between 1859 and 1869, first by Gruner, who suggested the idea of eliminating phosphorus from iron by basic methods, and then by Professor Müller, of the Ecole Centrale, who proposed a lining of magnesium. The war of 1870 put an end to further research. Professor Guillet described sympathetically the work of Sidney Thomas in association with his cousin, Percy Gilchrist, and of his final journey in search of health when he died in the Avenue Marceau, Paris, and was buried in the cemetery at Passy. Monsieur Guillet dealt also with the far-reaching effects of the Thomas-Gilchrist invention, which had rendered the Siemens-Martin process commercially possible, and had done much for non-ferrous metals, such as copper and nickel. Monsieur Piérard described the Thomas converter and explained the difference between the basic and acid systems, and stated that in 1930 no less than 98 per cent. of the total poduction of steel in France was obtained with basic lining. A communication from Monsieur Baclé, a former President of the Société des Ingénieurs Civils, gave a full account of the rise and progress of the metallurgical industry in the Centre and Est of France as the result of the introduction of the basic system, and said that French metallurgists were happy to commemorate the Thomas-Gilchrist invention, which had revolutionised the metallurgical situation. Monsieur Baclé confirmed the statement of Monsieur Portevin that we are on the eve of a new era in metallurgy, and added that experiments carried out at Commentry showed that it was possible to effect rapid and economical reactions between slag and the molten metal.

Monsieur Mathieu described what had been done in the way of electric smelting with basic lining, which was naturally centred in the hydro-electric sources of supply, for the sake of economy, and the fact that it was now extending to the northern districts was evidence of its growing vitality, though the production of electrically smelted steel was only about 2 per cent. of the total steel output. The electric furnace was particularly interesting on account of the possibility of making investigations into the influence of high temperatures. In 1931 the production of electrically smelted steel in France amounted to 158,000 tons.

Monsieur L. Croussard, General Inspector of Mines and Director of the Ecole des Mines at Nancy, dealt with the situation of the Lorraine Basin, which produces 80 per cent. of the French total of iron ore, one-half of which is exported to Belgium, Luxemburg, and Germany. He gave statistics of reserves and output, from which he concluded that the Lorraine mines would be exhausted within the allotted span of human life, while, at the present rate of extraction, the world's known supplies of iron ore were estimated to last not more than a century.

Sir Charles Wright thanked the President of the Republic on behalf of the Iron and Steel Institute for the opportunity given them of joining in the commemoration, and he hoped that his presence in an official capacity would strengthen the cordial relations that existed between the industries of the two countries. The proceedings concluded with an address by Monsieur Daladier, Minister of Public Works, who said that the Thomas-Gilchrist invention was not only technical, but of great national and economical importance, and he quoted figures of the Lorraine production showing to what extent France had benefited from the invention, alike from the point of view of the metallurgical industry and agriculture.

The arrangements terminated on December 6th with a visit to the cemetery at Passy, where a wreath was laid on the tomb of Sidney Thomas.

SIXTY YEARS AGO.

ALMOST from the day on which it was opened the London Underground Railway had encountered difficulties in dealing with the exhaust steam and smoke of its engines. Attempts were made to condense the steam and, when the trains were in the tunnels, to stop the emission of smoke by closing the ashpan doors and sealing the chimneys. The engines were intended to run on the steam generated while they were standing at stations, at which the ventilation was supposed to be better than it was in the tunnels. The drivers were, however, frequently compelled to disobey the regulations by opening the ashpans and using the blast to draw up their fires while they were passing through the tunnels. In addition to this failure to suppress the emission of smoke, the condensation of the exhaust steam was only partially successful, and as a result the Underground acquired an unenviable reputation for the insalubrity of its atmosphere. In actual fact the trouble proved insurmountable and persisted until the steam locomotive was banished from the system when it was electrified in 1905. Sixty years ago the users of the railway were actively protesting against the deleterious conditions under which they had to travel, and even the chairman of the company was forced to admit that something would have to be done either by changing the nature of the fuel or its method of combustion or by improving the ventilation of the tunnels. The city of Paris was about to establish its own underground railway and, profiting by our experience, was seeking some means of dealing with the difficulty in a rational manner right from the start. The General Council of the Department of the Seine laid down conditions which, it was recognised, made the use of the ordinary locomotive impossible. Numerous proposals were made with the object of meeting the Council's conditions. One suggestion advanced by Monsieur Paul Charpentier was described and illustrated in our issue of December 20th, 1872. It consisted of a steam locomotive using gas instead of coal or coke as fuel. The gas was to be carried in a compressed state in a cylindrical vessel mounted as a tender to the engine and was to be conveyed to the combustion tuyere in the engine fire-box through a flexible india-rubber pipe. Air in regulated amount was also to be admitted at the tuyere and the products of combustion were to be discharged through water. The exhaust steam from the cylinders was to be condensed. Discussing the proposal, we argued that while there would be great difficulties in the way of fully carrying out its details, there was nothing in it which would be found absolutely impossible. Time was, and not so very long ago, when the idea of lighting a train by gas had been deemed a somewhat chimerical proposition, and when cooking by gas had been sneered at. Yet both these developments had come about and it might quite well be, so we wrote, that the gas-driven locomotive was nearer to practical realisation than some might imagine.

ASSOCIATION OF CONSULTING ENGINEERS.

A PARTY of about 176 members and guests attended the annual dinner of the Association of Consulting Engineers, which was held last Friday at St. Stephen's Club, Westminster. The dinner was presided over by Mr. J. S. Alford, Chairman of the Committee of the Association, and in all respects maintained the reputation for good feeding, good speaking, and good companionship which previous dinners of the Association have established. The toast of "Engineering and the Empire" was proposed by Mr. Godfrey M. C. Taylor and was replied to by Sir Murdoch Macdonald, President of the Institution of Civil Engineers, and by Professor C. E. Inglis. Sir Murdoch, in his response, expressed the encouraging conviction that in Africa and other parts of the Empire there still remained a vast amount of work to be done by the civil engineer. The toast of "The Association of Consulting Engineers" was proposed by Mr. W. E. Tyldesley Jones, K.C. Contrasting the legal and the engineering professions, he pointed out that relatively to the Law ours was a newcomer, but that so far as consulting engineers were concerned the same rules of professional conduct and the same independence of interest had been established and were practised as were followed by the Bar and the Bench. Mr. Alford's acknowledgment of the toast brought the evening to a close.

Precision Grinding Machines.

No. XIII.*

CRANK SHAFT GRINDING.

SOME time elapsed after the plain cylindrical grinding machine had been successfully developed before any attempt was made to adapt it for the grinding of crank shafts. The Norton Company of America claims that its attempt made in 1904 to grind the pins of Ford crank shafts was the first of its kind, but there can be little doubt that the grinding of the line bearings of such shafts had been undertaken very much earlier. Although the attempt was a failure, the devices employed formed the seed from which present-day methods have developed. The grinding wheel had a width equal to that of the pins to be ground, and the crank shaft was made to revolve on dead centres, the correct "throw" being obtained by the use of somewhat crudely designed end blocks. Nearly thirty years have passed since this first attempt was made, and it now seems clear that its failure was caused not so much by unsuitable arrangements as by the lack of experience of the operator. The advantages that it was believed would be found if crank shafts could be ground were such that in spite of this setback further experiments were soon made. Two live heads were next adopted, and the shaft was supported on centres correctly placed to give the required throw when the spindles were revolved. Owing to the mechanical difficulty of maintaining the two live heads in alignment, later designs reverted to the older end-block method, and machines of this type were brought to a high state of efficiency. Firms with a large production of one type, or those making a number of different designs of crank shafts, found, however, that when such machines were used an uncomfortably large stock of end blocks had to be carried, and this objection led to the design of machines similar to those in use at the present day, in which a substantial and adjustable end block is solidly attached to the live spindles of the work heads. Suitable gearing interconnects the spindles of the two heads and maintains their alignment.

A TYPICAL EXAMPLE.

The machine illustrated in Fig. 91 is made by the Norton Company of America, for which Alfred Herbert, Ltd., of Coventry, holds the agency in this country. It is capable of swinging work up to 17in. in diameter, and is made in a range of lengths suitable for shafts up to 60in. long. In order to obtain proper alignment of the work spindles, the left-hand head is given lateral adjustment, while for the accommodation of different lengths of work, that on the right has a longitudinal movement of 12in. Synchronisation of the movements of the two spindles is obtained by driving them from a motor at the back of the machine through silent chains, the tension of which is maintained by idler sprockets. The work holders are fixed on the splined heads of the spindles, and are fitted with hardened steel bushings to receive the end bearings of the crank shaft. Clamps operated hydraulically hold the shaft in position, and are so interlocked with the other control levers that they cannot be released while the spindles are in motion. Ease and rapidity of setting-up identical crank shafts is ensured by the provision of suitable angular and longitudinal locating devices. The grinding wheel has a width equal to that of the pins to be ground, and has fillets at the corners. It is fed inwards hydraulically, rapidly at first to the grinding position, and then more slowly while forming the shoulders of the pin, being finally brought up to the sizing stop by hand. A rapid return to the idling position is provided by the hydraulic motion. On the latest machines, such as that illustrated, there is a new design of steady rest, which, when unclamped from the table, swings up out of the way to provide easy access to the shaft. At the same time the supply of coolant is automatically stopped.

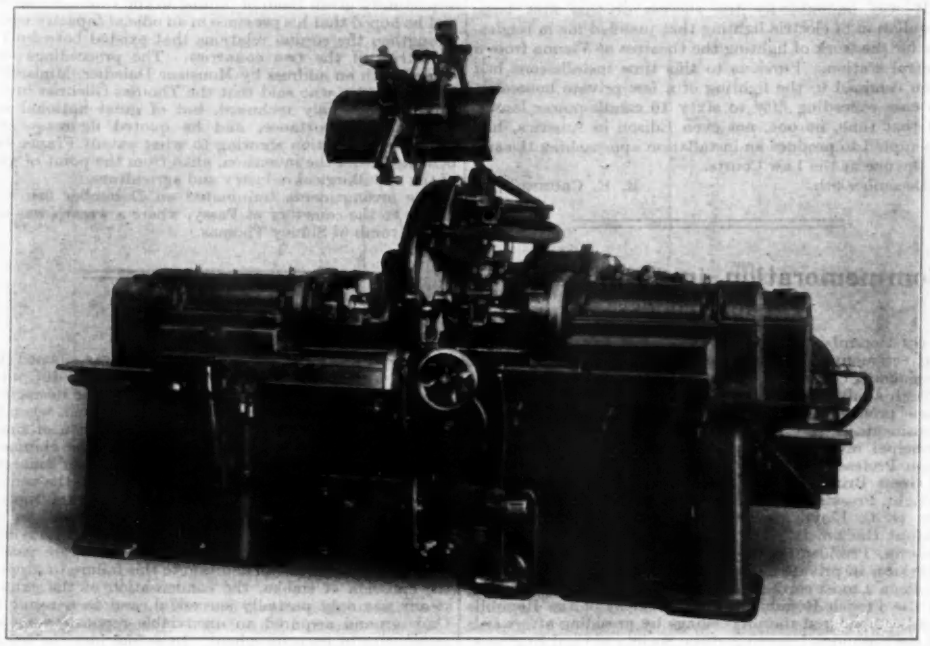

FIG. 91—NORTON SINGLE WHEEL CRANK SHAFT GRINDER

FIG. 92—LANDIS MULTIPLE WHEEL CRANK SHAFT GRINDER

FIG. 93—LANDIS CAM SHAFT GRINDING MACHINE

A MULTIPLE WHEEL DESIGN.

Where crank shaft grinding is concerned, there are obvious advantages to be gained by grinding simultaneously all those pins which are in axial alignment. The plan necessitates the use of more than one grinding wheel, and the machine illustrated in Fig. 92 is a good example of the type. It is made by the Landis Tool Company, and is shown utilising two grinding wheels to grind the outer pins of a four-throw crank shaft simultaneously. Unlike the majority of grinders, this machine is so designed that the wheels are mounted on the spindle between bearings, instead of on the overhang. Like the majority of plunge-cut grinders, the feed of the wheel is controlled hydraulically. On setting the machine to work, the wheels are advanced rapidly at first to the grinding position, feeding thereafter at a predetermined rate to the sizing stop, and returning rapidly after the conclusion of the operation to the idling position. A longitudinal shaft at the front of the machine is rotated by a 2 H.P. motor, through worm and wheel reduction gearing, and drives the two work heads by means of silent chains. A brake included in the mechanism comes into action when the control lever is put into the "Stop" position. Besides grinding the pins this machine may advantageously be used for forming the line bearings. The crank is mounted between plain workheads, and three wheels are suitably spaced on the grinding spindle opposite the three bearings to be ground.

In connection with the type of machine described in this section, it is interesting to note that the development of successful crank shaft grinders has had repercussions on the design of the crank shafts themselves. In automobile work in particular, many such shafts are now designed without webs that need machining, and some are so arranged that all the machining operations, both roughing and finishing, can be performed on the grinder.

CAM SHAFT GRINDING.

Whether the cam is in the form of a separate piece, later to be attached to the cam shaft, or whether it is formed integrally with that shaft, the principles upon which the cam shaft grinding machine operates are the same. The cam shaft is mounted on a fixture which is able to oscillate around a centre in such a way that the shaft may be advanced towards or retracted from the grinding wheel. For each cam the movements of the oscillating fixture are controlled by a master cam, which is held in contact with a roller by spring pressure. The master cams are usually made on the same machine that later will grind the cams themselves, and the methods adopted for forming these controllers will be described shortly.

A machine made by the Landis Tool Company and brought to our notice by Burton, Griffiths and Co,, Ltd., is illustrated by the two engravings Figs. 93 and 94. It is almost completely automatic in operation and is particularly suitable for the grinding of motor car and petrol engine cam shafts. The operator places the cam shaft in the machine against suitable locating devices, throws the quick-acting jaw steady rests into position, starts the work rotation by pressing a push button, and lastly throws over the main control lever. The work carriage then moves automatically into the correct position for grinding the first cam and at the same time the work cradle swings towards the grinding wheel until the master cam makes contact with the roller. Meanwhile the grinding wheel is fed rapidly forward to the grinding position, after which it slows down and reduces the cam to the correct form at a predetermined speed. At the conclusion of the operation on the first cam the wheel returns to the idling position, the work cradle moves back so that the master cam leaves the roller, and the table traverses automatically into position for the grinding of the next cam, the roller at the same time moving to a position opposite the correct master cam. The cycle of operations is repeated for each cam on the shaft and when completed the grinding wheel moves back to the idling position and the cradle moves back and causes the master cams to leave the roller. The operator must then stop the work rotation and remove the shaft.

The master cams and roller are housed in the box to be seen on the left in Fig. 94. A piston contained in the cylinder fixed to the side of the work

* No. XII. appeared December 9th.

head and actuated by hydraulic power is attached to the work cradle and swings it and the master cams away from the roller, when the indexing motion from one cam to the next is taking place. Spring pressure holds the master cams against the roller when the actual grinding of a cam is taking place.

THE MAKING OF MASTER CAMS.

It will be appreciated that if the cams are to be correctly formed in a cam shaft grinder the master cams must be very accurately made. Before the making of a master cam can be undertaken all the information necessary to set out the shape of the finished cam on a drawing board is required. It is of importance for instance, that the tappet clearance, if any, should be given, and if the cam is to operate against a roller the diameter of the latter should also be stated. In the case of integral cams a complete valve diagram for the engine is required so that the cams may be formed in their correct relative positions. Having collected all the information, the usual practice is to make a full-scale model of the completed cam, finished to exact dimensions by hand. In the case of integral cams the model will include all the separate cams in their correct relative angular positions, but laterally they will be brought very close together. From these model cams the master cams may be generated on the cam grinding machine by making suitable modifications to its arrangement. The grinding wheel of the machine is removed and a disc with a hardened steel periphery of the same diameter as the wheel is fixed to the spindle in its place. The shaft carrying the roughly formed and hardened master cams is placed in the work cradle and the model cam is placed axially in line with it and is held in contact with the disc by spring pressure. Thus when the work and the disc are rotated the master cams will be given a to-and-fro motion dependent upon the shape of the model cam, which is bearing against the disc. A small grinding wheel of a diameter equal to that of the roller against which the master cams will bear when used to control the grinding operation is mounted on a special belt-driven spindle running in suitable bearings clamped to the back of the bed. The master cams are fed against it by altering the position of the disc. In this way the master cams are so formed that when placed in the machine and made to run against a roller of the same diameter as the wheel which ground them to size they will cause the work cradle to oscillate backwards and forwards by an amount such that a grinding wheel equal in diameter to the disc will generate a cam form identical with that of the model cam. That the grinding wheel should be exactly the same diameter as the disc by the use of which the master cams were made is not very important. The amount of variation permissible alters according to the shape of the cam and the limits of accuracy to which it is to be made.

FIG. 94—GRINDING CAM SHAFT IN LANDIS MACHINE

It is unlikely that a wheel 1in. too great or too small will bring about too large a variation and in some cases wheels worn down by as much as 4in. on the diameter may still generate a cam nearly identical with the original model. The diameter of the roller against which the master cams bear is of much greater importance and fortunately very little difficulty need be experienced in making and keeping it the correct dimensions.

SPLINE SHAFT GRINDING.

It is a curious reflection on the origin and development of the grinding machine that a very large number of the grinding operations now used extensively in general engineering were first brought into being by the requirements of automobile engineers. Crank shaft and cam shaft grinding machines were both first applied to the making of automobile parts, and are still more extensively used in that industry than in any other, while both external and internal cylindrical grinding machines owe much to the desire of automobile engineers to eliminate, as far as possible, all those fitting operations that are so expensive in time and money, and which play havoc with any attempt to make every operation in the manufacture of a motor car part of a mass-production job. As with crank shafts and cam shafts, it was the automobile engineer again who had the greatest desire to see the machining of spline shafts brought to such a state of perfection that subsequent fitting would be eliminated. Not so many years ago the key was almost universally employed for driving any part fitted to a rotating shaft, but the use of this device has the great disadvantage in the eyes of the automobile engineer that fitting is a necessity. Even in general engineering, it is coming to be recognised that for many purposes the spline shaft is a better device than the key. Where, for instance, a large amount of power has to be transmitted through a small diameter shaft, the ability of the spline shaft, when properly made, to spread the bearing pressure over several surfaces makes it preferable, but if it is to be more efficient than the key in this respect its accuracy must be immaculate. Makers of spline shaft grinding machines claim that by no other process can the required accuracy be obtained.

There are at least three important methods of grinding spline shafts in use at the present day. One makes use of a single grinding wheel formed to the shape of the slots, which grinds the minor diameter and the flanks of the splines in one operation; a second separates the two operations and utilises one wheel to grind the minor diameter and two other wheels mounted together on a separate spindle to grind the flanks of the splines; while a third, using three wheels mounted on a single spindle, grinds the minor diameter with the central wheel and the flanks of the adjacent slots on each side with the others.

The machine illustrated in Fig. 95, and made by the Gear Grinding Company, Ltd., of Handsworth, Birmingham, employs the first-mentioned method. It is capable of accommodating work up to 3in. in diameter and 20in. long, or up to 4in. in diameter for certain other lengths, and is suitable for grinding any number of splines. In general, its design, as will be seen from the engraving, is similar to that of a horizontal spindle surface grinder. The work table is carried on the top of the main reciprocating table on one "V" and one flat slide. These two guides form an inclined way with a slope relative to the horizontal ways of the main table of 1 in 32. Instead of feeding the wheel downwards into the work in the usual way, the work is fed upwards by drawing the work table up the inclined plane. The reason for this modification of the more usual practice is connected with the arrangements for trimming the wheel, but it will be seen that it provides a particularly sensitive and accurate method of controlling the cut. Reciprocation of the main table is performed hydraulically by a piston and ram mechanism, while the indexing round of the shaft to bring one slot after the other into the grinding position is also controlled hydraulically. The dividing head is mounted at the right-hand end of the work table. Its spindle is hollow, with a 3in. diameter bore through which shafts longer than the capacity between centres of the machine can be passed and held in a collet. The index plate is supported on the spindle at the back of the head. It has a number of radial faces corresponding to the number of the splines on the shaft, and these faces are accurately ground by a process which will be described in a subsequent article of this series. They are held in contact by hydraulic pressure with a locating pawl, which is lifted when indexing takes place.

The wheel is trued to the correct form by three diamonds mounted on the trimming device, which stands on the left-hand end of the main table. Two of the diamonds are held in levers adapted to swing through a small angle in a plane the angular position of which is determined by the number of splines to be ground. These so-called "side diamonds" have micrometer screws for setting to size and for wear adjustment. The third diamond tool, usually termed the "bottom diamond," trues the surface of the

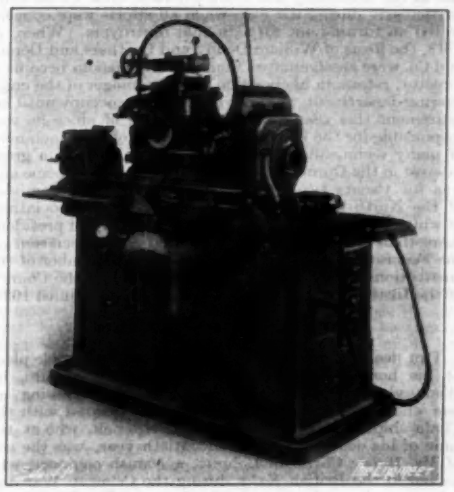

FIG. 95—SPLINE SHAFT GRINDER—GEAR GRINDING CO.

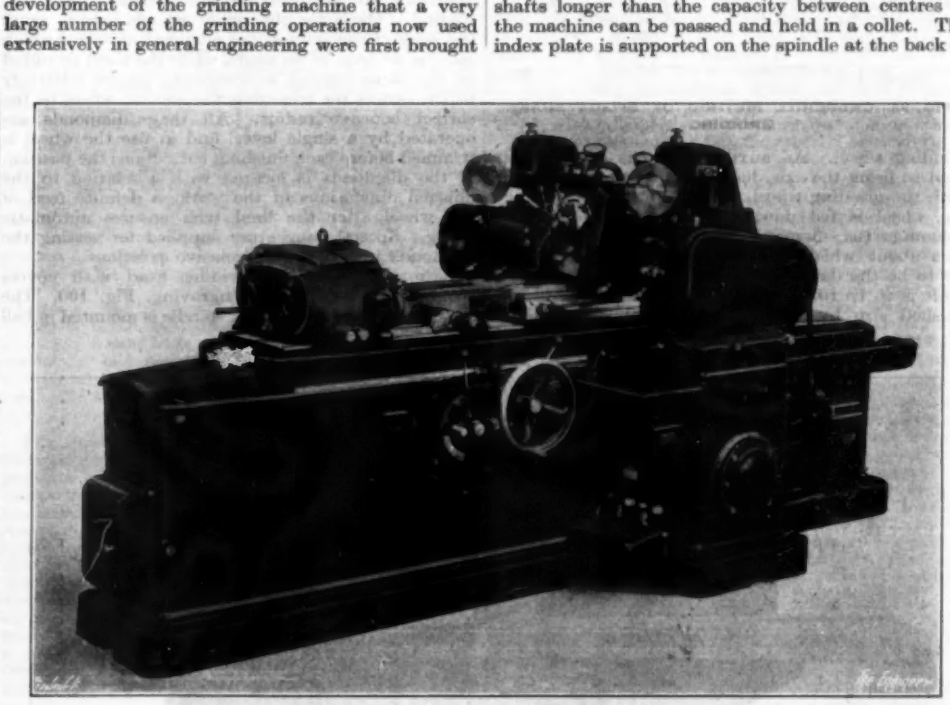

FIG. 96—WERNER SPLINE SHAFT GRINDER

wheel forming the bottom of the splines and is mounted in a hardened and ground spindle, the axis of which is the datum to which the axis of the work piece is raised during the grinding operation. The grinding wheel at each trim is trued to the finished size of the shaft, and not afterwards moved, and it follows that when the axes of the work piece and trimmer

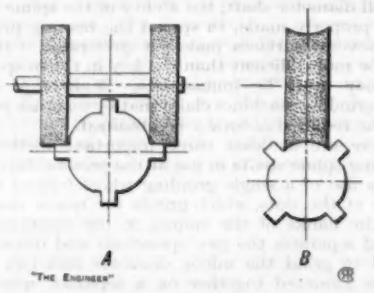

FIG. 97—TWO-OPERATION METHOD OF SPLINE SHAFT GRINDING

coincide, the work is to size. The trimmer is hand operated, and all the diamond tools are moved together by one lever.

When it is necessary to trim the grinding wheel the main table is tripped by hand and travels beyond its normal working stroke to a fixed stop which brings the bottom diamond under the centre line of the

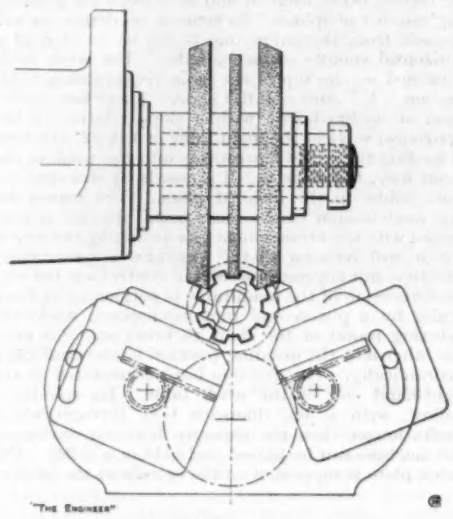

FIG. 98—CHURCHILL METHOD OF SPLINE SHAFT GRINDING

grinding wheel. An auxiliary stop is subsequently used to bring the side diamonds into proper relation with the grinding wheel. When it is to be trimmed the wheel is fed down the slides of the vertical column; the diamonds are not moved and the axis about which the bottom diamond rotates is set to be the datum to which the axis of the spline shaft is to be raised. Thus, the spline is formed to finished size by trimming the wheel, and, without altering its vertical adjustment traversing it horizontally along the shaft, which has been raised to the correct datum level.

THE TWO-OPERATION METHOD.

A machine made by Fritz Werner A/G, of Berlin, for which E. H. Jones (Machine Tools), Ltd., of Islington, London, holds the agency in this country, is illustrated in Fig. 96. It grinds the splines on the two-operation principle, shown diagrammatically in Fig. 97. The workhead is double, so that two spline shafts are accommodated together on the one machine. The first operation of grinding the flanks of the splines—A, Fig. 97—is performed in one position, and the shaft is then transferred to the other, where the minor diameter is ground to size—B, Fig. 97. The transference of the shaft from the first position to the second is facilitated by the design of the driving fixtures on the double workhead. On each spindle of the workhead there is clamped a driving plate adjustable for angular position and having two slots. Each spline shaft revolves upon centres and is rotated by means of a driver clamped on to the shaft and engaging with one of the slots in the driving plate. A special gauge capable of sliding on the ways of the table, makes the rapid setting of the spline shafts easy, and once the two driving plates on the two spindles of the workhead have been set in position, each spline shaft can be transferred, without resetting, from the first position to the second by running back the tailstock centres and removing it together with the attached driver. Retraction of the tailstock centres is brought about by the depression of a pedal, so that both the operator's hands are free to manipulate the work. The table is hydraulically driven and the feed is automatically stopped when the shafts are ground to size. This latter operation is performed by correctly positioned feelers which make contact with the faces being ground at each stroke.

USE OF THREE GRINDING WHEELS.

While the two-operation method of grinding spline shafts has the advantage that each can be separately controlled and any errors thereby localised, the necessity for transferring the shafts from one spindle to another has a limiting effect upon the output. In the latest machine made by the Churchill Machine Tool Company, Ltd., of Manchester, this objection is overcome by mounting the three grinding wheels side by side on a single spindle, as shown in Fig. 98, and performing the two separate operations simultaneously. A general view of the largest machine of the range made by this company is given in Fig. 99. It is suitable for shafts having any number of splines up to twenty and lengths up to 52in. In a spline shaft grinding machine two features are of the greatest importance. The indexing mechanism must be soundly constructed and accurate in operation, while the diamond trimming device must be so designed as to be capable of accurately facing the wheels to the desired shape. The line engraving, Fig. 98, shows diagrammatically how the three diamonds are arranged on the machine under discussion. Those for the outer wheels, which grind the sides of the splines, are mounted on slides which may be set over at an angle, while the third mounted on the same casting is accurately placed relatively to the others for trimming the central wheel to the correct concave radius. All three diamonds are operated by a single lever, and in use the wheel is trimmed before each finishing cut. Since the position of the diamonds is located with a relation to the finished dimensions of the work, a definite feed of the wheel after the final trim ensures automatic sizing. Special gauges are supplied for setting the diamonds in the correct relative positions.

A rear view of the dividing head with covers removed is given in the engraving, Fig. 100. The large diameter hollow work spindle is mounted in ball

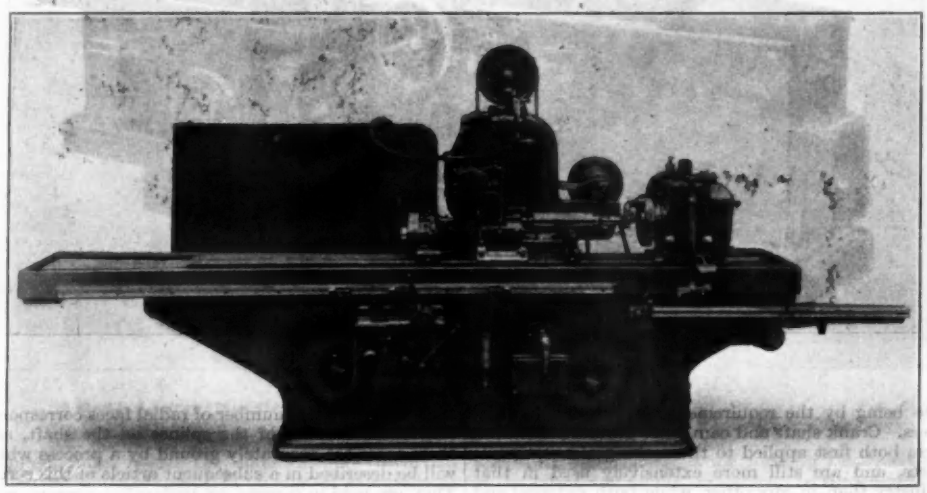

FIG. 99—LARGE CHURCHILL SPLINE SHAFT GRINDING MACHINE

bearings. It carries at its rear end a disc having a suitable number of V slots cut in its periphery, which are engaged by a spring-loaded plunger when indexing to the correct position has occurred. The drive to the indexing mechanism is taken by belt from the main driving shaft to a transverse shaft on the workhead, which transmits its motion through bevel gears to a lay shaft placed parallel to the main spindle and driving it through spur gearing. A clutch operated automatically by a trip mechanism on the machine causes one complete revolution to be given to the lay shaft in the head at the completion of each cycle of the grinding operation. Besides the alteration to the design of the machine involved by mounting the three grinding wheels on the one spindle, the grinding head has been redesigned to take the heavier loading that now comes upon it.

FIG. 100—INDEXING MECHANISM

The traverse of the table is operated by the usual Churchill hydraulic mechanism and provides an infinite range of speeds up to 35ft. per minute.

(To be continued.)

Obituary.

ENGINEER COMMANDER WILLIAM M'K. WISNOM.

NAVAL engineers and shipbuilders will learn with regret of the death of Engineer Commander William M'K. Wisnom, of Auchenfroe, Cardross, who for many years was the engineering manager of William Denny and Brothers, Ltd., of Dumbarton, and only recently retired from the board of the company. Commander Wisnom was the eldest son of the late Mr. Samuel Wisnom, of Altahammond Whitehead, County Antrim, and after leaving school spent his early years in the engineering branch of the Royal Navy at Portsmouth Dockyard, Keyham College, Devonport, and the Royal Naval College at Greenwich. He rapidly rose in rank to chief engineer and engineer commander, and was for a long period assistant engineer inspector at the Admiralty. During this period of service he was closely associated with the development of turbine propelling machinery for destroyers and other vessels. He retired from the Navy in 1903 and five years later he joined Denny and Co. at Dumbarton as engine works manager. His long experience in the Navy and at the Admiralty was of the greatest value to the firm, particularly during the war, when all efforts were concentrated on turning out torpedo-boat destroyers. When, in 1918, the firms of William Denny and Brothers and Denny and Co. were amalgamated Commander Wisnom became a director, retaining his position as the manager of the engineering department, which he continued to occupy until his retirement this year. During his period of office he was responsible for the successful completion of the machinery of many technically difficult contracts. He took a great interest in the Dumbarton Employers' Welfare Scheme and was for twenty-two years a member of the Committee of the North-West Engineering Employers' Association, of which he held the offices of vice-president and president more than once. He also represented the Association on the Federation General Council. He was a member of the Institution of Naval Architects and served on the Council of the Institution in 1913, remaining a member until 1929.

SIR FREDERICK LOBNITZ.

THE death of Sir Frederick Lobnitz, which took place at his home, Ross Hall, Crookstow, Renfrewshire, on Wednesday, December 7th, marks the passing of one who for over half a century was associated with the Clyde shipbuilding industry. Sir Frederick, who at the time of his death was in his seventieth year, was the son of Mr. Henry Christian Lobnitz, a Danish engineer, who served in the British Navy during the Crimean War and subsequently took over the business of Henderson and Colburn, shipbuilders, of Renfrew. Young Lobnitz received his education abroad, and on his return to Scotland served his apprenticeship with the Govan firm of John Elder and Co. He subsequently joined his father's firm and was the inventor of many improvements in connection with the design and construction of dredging machinery, in which his firm specialised. One of the principal developments with which his name will always be associated was the method of excavating rock under water without the use of explosives. That method has been successfully employed in many overseas harbour and canal schemes. For many years Sir Frederick was the chairman of Lobnitz and Co., Ltd., of Renfrew. Early in the war he rendered valuable service to the country in promoting the manufacture of munitions by unskilled labour, and in 1915 he was made Deputy Director of Munitions in Scotland and Director of Munitions in 1917. For these national services Sir Frederick received from the French Government the order of an officer of the Legion of Honour in 1919, and the following year he was made a Knight of the British Empire. He was a member of the Institution of Civil Engineers and carried out important works with his brother-in-law, the first Viscount Cowdray, in many of the successful Pearson undertakings. He did much for his birthplace, the Burgh of Renfrew, of which he was made a Freeman.

Railway and Road Matters.

TRAFFIC on the Southern Railway continues to improve. That company's traffic returns for the forty-eighth week of the year shows an increase of £3000 in its passenger receipts and of £5500 in its coal traffic, whilst its goods receipts were only £500 down.

THE position of works superintendent (locomotives), Derby, L.M.S., vacant by the transfer of Mr. H. G. Ivatt to be divisional mechanical engineer, Glasgow, has been filled by the appointment of Mr. G. S. Bellamy, hitherto assistant to the superintendent of motive power.

Two of the Great Western divisional locomotive superintendents are about to retire. One is Mr. E. G. Wainwright, of Wolverhampton, who will be succeeded by Mr. R. H. Grey, assistant to the locomotive running superintendent and outdoor assistant to the chief mechanical engineer. The other is Mr. E. G. Ireland, of Newport, who will be followed by Mr. W. E. Baines, of Neath.

THE result of the fortnight's trial of the non-use of the amber light in the street traffic signals in Oxford-street and at the intersection of Pont-street with Sloane-street, is being dealt with in the report of the Departmental Committee on road traffic signs. Mr. Pybus, answering a question on that point on December 7th, said that the Chairman of that Committee had informed him that the opinion was that the amber light should be retained.

DURING the month of August last, when compared with the corresponding month of 1931, 3·4 per cent. fewer passenger journeys were made and the receipts from passengers decreased by 9·6 per cent. For the four weeks ended September 10th the tonnage of freight decreased by 13·2 per cent. and the freight train receipts by 16·5 per cent. The freight train miles were brought down by 8·8 per cent., but the average train load fell from 123¾ to 115¼ tons and the net ton-miles per engine hour from 455½ to 436¼.

THE matter of the refusal of the Railway Rates Tribunal to sanction some flat rates on the Great Western Railway, mentioned herein on December 2nd, led to a question being addressed to the Minister of Transport on December 1st, as to whether he would bring in a Bill freeing railway companies from such statutory obligations as were out of date for present-day requirements. The answer given was that the Minister would, of course, be prepared to consider any representations which the railway companies might wish to make to him as to the general bearings of the decision.

THE death occurred on December 4th, following a severe operation, of Mr. Richard Popkiss, M. Inst. C.E. Mr. Popkiss had been a director of the Cordoba Central Railway Company, Ltd., for twenty-three years, and at the date of his death was chairman of the Great Southern of Spain Railway Company and a director of the Interoceanic Railway of Mexico, Mexican Southern Railway, Mexican Eastern Railway, and the Vera Cruz Terminal Company. He was also for a number of years, until recently, on the board of the United Railways of Havana and associated companies. During his long career as a civil engineer he superintended railway construction work in Spain, Ceylon, Costa Rica, Mexico, and other countries.

VERY important proposals are contained in the Bill now being promoted by the Dover Harbour Board. In various ways the Board, under statutory powers and by agreement, is subject to the Southern Railway Company. It is proposed to abolish this control, so that the "Harbour Board should cease to be otherwise subject to the consent and control of the Southern Railway Company in carrying on their undertaking." The Bill also seeks power for the construction of a tunnel railway from the Deal branch of the Southern Railway to the Dover dockyard, where an embankment and a pier would be built; for additional members to be appointed to the Harbour Board; to cancel the £1,000,000 Dover Harbour redeemable debenture stock; to increase the poll tax; and to conduct a cross-Channel service of vessels for conveyance of passengers and goods between Dover and the Continent.

WHEN the Western Extension of the London Electric Railways was opened and the then four lines west of Hammersmith could be used in common by the trains of the Metropolitan District and those of the London Electric an interesting problem presented itself. It lay in the fact that it was physically possible for a District eastbound train to leave Hammersmith and to proceed on to the tube railway where the tunnels are not of such dimensions as to admit the larger stock of the District Railway. Three mercury-filled U-shaped glass tubes were therefore provided over the eastbound tube track which are clear of the London Electric stock, but are foul of the District coaches, and, in the event now being referred to, would be broken by the latter and the mercury released. That would open the electrical circuits operating the London Electric eastbound signals at that point and put them, and their train stops, to "danger" and so stop any District train from going on to the tube lines.

HEREIN, on December 2nd, it was related that the Irish Railway Wages Board had made an award approving of the companies' proposals that the reduction of 5½ per cent. in the men's wages should be increased to a reduction of 10 per cent. The men refused to accept the award, and threatened to strike if it were put into effect. A difficult political situation then arose, as the Labour Party, who mainly are supporters of the present Government, sided with the men. That situation was aggravated by the Government having some months ago promised a Transport Bill, which was to help the railways in their losses from traffic transferred to the roads. Finally, the problem is complicated by some of the railway servants being in Northern Ireland, and therefore not subject to any action that might be taken by the Free State Government. Towards the end of last week the latter Government offered to subsidise the companies until legislation was passed, but that offer was refused. A general strike last Sunday appeared certain, but on the previous day it was at all events postponed for a week. The Free State Government's offer is to subsidise the companies until April 30th next, conditionally on the railways discharging no more men. The Northern Ireland Government has, however, made no offer at all.

Notes and Memoranda.

IT has been found in Canada that if piles of road metal which may have to be handled in the winter are sprinkled with calcium chloride as they are built up, they will not freeze solid, and can be easily shovelled.

THE exports from Canada of aluminium and manufactures of aluminium to the United Kingdom during the first six months of the present fiscal year were valued at 602,237 dollars, compared with 517,947 dollars in the same period last year. Aluminium in bars, &c., amounted to 4,120,200 lb., compared with 2,255,400 lb. last year.

IN the issue of the *Machinist* (formerly the *American Machinist*) for December 10th, there is a most informative article by Mr. H. Shaw, of Heywood, England, on the production of sheet metal articles by bulging them within dies by hydraulic pressure. Such a complicated form as a model hand can be made in seamless aluminium in five operations.

AS a test of the bending strength of Armourplate glass, Pilkington Brothers, Ltd., of St. Helens, recently made up a rig in which a sheet of glass 40in. by 24in. by 1in. thick was used as a beam. It was lifted at the ends by a sling from a crane. At the centre there was suspended a cage carrying three elephants, and three men attendants. The total weight was over 5 tons. This load was raised without fracturing the glass, although it was bent slightly.

ACCORDING to *Steel*, an average American motor car weighing 2665 lb., without oil, petrol, or water, contains 492 lb. of malleable and cast iron, 1606 lb. of steel in various forms from heavy frame stock and axles to wire, making a total weight of 2098 lb. of iron and steel. The remainder is made up largely of 198 lb. of wood, 82 lb. of rubber, 54 lb. of glass, and 53 lb. of cotton. Other metals embrace 26 lb. of brass, 20 lb. of lead, 17 lb. of copper, and 5 lb. of tin. Miscellaneous materials weigh 112 lb.

A NOTE by "Peterborough" in the *Daily Telegraph* says:—Tower Bridge has been described as an "expensive toy," but how expensive is not generally known. Its cost to the City of London for twelve months works out at £30,502, compared with a total of £6324 for Blackfriars, London, and Southwark bridges. Wages of the engineer's and bridgemaster's staff at Tower Bridge accounts for £14,649. There is a big drop to the next item, one of £2821 for a tug kept in readiness in case of accidents which do not occur. Following this is £2800 for cleaning, £2605 for maintenance of paving, £2514 for gas lighting, and £1368 for coal and coke. The cost of the hydraulic power is only £82 10s.

IN the course of a paper on the "Behaviour of Steel in Sulphur-containing Atmospheres at Forging Temperatures," Mr. D. W. Murphy dealt with the effect of high sulphur in the coal or other fuels in heating furnaces. One important finding was that the use of high-sulphur fuels, containing 1 to 2 per cent. sulphur, in forging furnaces, was likely to increase scaling losses and result in poorer forgings by reason of sulphur introduced into the outer layers of the steel. Hence the sulphur content of fuels for use in forging furnaces should never exceed 0·50 per cent., and should preferably be kept well below this figure. When high-sulphur fuels are used, operations should be conducted under reducing conditions to prevent excessive sulphur resulting in the outer layers of the steel.

IN his reply to the discussion of his paper on the use of soda-ash in the ironfoundry, read before a joint meeting of the British Cast Iron Research Association, and the London Section of the Institute of British Foundrymen, Mr. N. L. Evans said that he did not recommend the use of soda ash for steel because of the violence of the reaction and the danger of the metal being thrown out of the ladle. It was within a range of temperature of 1300 deg. to 1400 deg. Cent., that the reaction showed the greatest efficiency. The best means for avoiding trouble with the linings of ladles and cupolas was to use an aluminous fire-brick, which, however, was very expensive. Nevertheless, he had been assured by practical foundrymen that the advantages amply compensated for the additional cost. The best method of adding the soda ash was to put it in the bottom of the ladle, and also to heat the ladle.

THE annual report of the Department of Agriculture, Federated Malay States and Straits Settlements, points out that increasing attention has been paid to improvements in rubber factory machinery and equipment, particularly in the preparation of smoked sheet. As a result of the work of a number of estates, batteries of light sheeting machines in cascade or file formation have been developed and are in use, capable of outputs of from 2000 lb. to 3000 lb. of dry rubber per hour, or even more. The resultant saving in capital costs and running expenses on large estates will be very considerable, since a small factory with a battery of five or six light sheeting machines is sufficient alone for an area of 6000 acres or more. Improvements in the ventilation and design of smoke-houses and smoke-house fire-boxes are also resulting in economies in consumption of wood fuel combined with more rapid drying and smoking.

IN a paper presented to the Physical Society, Mary D. Walker described the vibrations produced in bodies in contact with solid carbon-dioxide, under which conditions very loud notes may be produced and maintained for a considerable time in metal objects capable of vibration, such as tuning forks, bars, discs, rings, and tubes. Notes have also been sustained in quartz crystals. It is shown that the vibration frequencies normally excited may range from about 1000 to 15,000 ~. Lower frequencies have been excited in wires. Surface tension ripples may be produced on mercury. The vibrations are only produced by solid carbon-dioxide of high density. The physical properties of the vibrating body which are of importance in connection with the phenomenon were considered in the paper, and evidence brought forward in favour of the view that the source of energy for producing the vibrations is the heat which is given up by the metal to solid carbon-dioxide, and that the efficacy of this substance in producing vibrations is determined by the fact that it sublimes and in so doing produces considerable gas pressures.

Miscellanea.

A DRY dock capable of accommodating the largest liners afloat is to be built at Naples.

A NEW field of anthracite coal has been discovered on the Bandrum-Rhynd Estate, near the village of Saline, Fife.

A FOUNDRY for the production of light aluminium alloys is to be put up on the site of the old Cyfarthfa Ironworks, Merthyr Tydfil.

THE importation of foreign iron and steel into the Tees amounted only to 200 tons in November. In November of last year the unloadings were 19,005 tons.

A VEIN of lead ore has been discovered at the Halkyn Hill Mold Mine, Flintshire. It is expected that it will provide employment for about 1000 men.

IT is proposed to put up an electric generating station at Kandahar, Afghanistan, at a cost of Rs. 2,00,000, and a motor repair factory at Kabul, at a cost of Rs. 50,000.

IT is intended that the new aluminium smelting plant at Dniepostroi should start work with the New Year. The projected output is 40,000 tons of aluminium per year.

ANTI-COAL-BREAKING plant is to be installed at the Bedlington Coal Company's Doctor Pit, Northumberland, to prevent coal being broken while being loaded from screens into trucks.

THE deposits of manganese ore discovered 4½ miles from Passaje, El Oro Province, Ecuador, are estimated to contain fully 120 million tons of ore. A number of bore-holes have been sunk to a depth of 28ft. without reaching the bottom of the ore body.

THE various factors that may be involved in the subsidence of London as revealed by recent re-levelling have been enumerated with comments in a paper by Capt. T. E. Longfield (Ordnance Survey, Professional Papers No. 14, "The Subsidence of London," price 2s. 6d.).

A REFINERY for the production of 100,000 tons of copper a year is being put up near Sverdlovsk, in the Ural district of Russia. The ore is to come from the Diedcharinsky mines. Incidentally, some 400,000 tons of sulphuric acid are to be produced per annum.

DURING 1931 the seaplanes employed in the fisheries patrol service in British Columbia, under the Dominion Department of Fisheries, were on flying duty about 320 hours. Planes have been used in this service for several years past, with, says *Canada*, very satisfactory results.

WE are informed that the Dutch Government has decided to adopt the latest type of Yarrow high-pressure boiler in the new cruiser which is to be built by Messrs. "Wilton-Fijencoord," of Rotterdam, and that Yarrow and Co., Ltd., have received an order for complete working drawings.

WITH regard to the electrification of the branch of the Baku-Batoum railway which leads up to the Suram Pass, the *Electrical Review* states that the traffic consists of trains of oil-tank wagons, for the hauling of each of which three powerful locomotives have hitherto had to be employed. Through the conversion it has been possible to replace fifty locomotives, which consumed 100,000 tons of oil fuel per annum, by eighteen electric locomotives. The transport capacity of the line has been increased by two to three times, while the speed is from 30 to 70 per cent. higher.

THE Bombay, Baroda and Central India Railway has accorded its final approval to the selected design for the new bridge to be built over the Nerbudda River at Broach, in the Bombay Presidency, and tenders have been invited for the construction of this bridge. Nearly a mile in length, the bridge will probably be the largest railway engineering project to be undertaken in India during the next few years. Apart from dimensional details, the scale of the undertaking is denoted by the fact that the total quantity of steel required will amount to 13,137 tons, and the cost of the whole scheme will be about a crore of rupees.

THE Official Returns rendered to the Electricity Commissioners show that 1228 million units of electricity were generated by authorised undertakers in Great Britain during the month of November, 1932, as compared with the revised figure of 1095 million units in the corresponding month of 1931, or an increase of 133 million units, or over 12 per cent. During the first eleven months of 1932 up to the end of November the total amount of electricity generated by authorised undertakers was 10,958 million units, as compared with the revised figure of 10,190 million units for the corresponding period of 1931, representing an increase of 768 million units, or 7·5 per cent.

THE construction of the Masson Falls project of MacLaren-Quebec Power Company is, says the *Canadian Engineer*, proceeding according to schedule, and good progress has been made with the development which is expected to be in operation by July, 1933. One of the major features of the job was boring a tunnel about one mile in length; practically all of this work has been completed with the exception of the last 100ft. Already the company is producing 75,000 H.P. at High Falls. At Masson Falls an installation of 130,000 H.P. is planned, the completion of which will enable the company to take care of a contract with the Ontario Hydro-Electric Commission for 125,000 H.P.

ALMOST all the metals produced in Canada to-day are refined in the Dominion, instead of being exported in the raw state as formerly, according to Mr. R. W. Brigstocke, consulting mining engineer, Toronto. There are seven copper smelters, he says which feed three refineries whose capacity is ten times the annual consumption of copper in Canada, and is equal to the demand from the whole Empire. Even more striking are the cases of nickel, lead, zinc, aluminium and cobalt, to say nothing of gold and silver, all of which are produced in refineries that lead the world in equipment and technique. Thus, in less than one generation, Canada has advanced from the position of a purveyor of raw minerals to foreign smelters and refineries to a prominent position in the supply of refined metals.

HYDRAULIC POWER STATION AT LEITH DOCKS

(*For description see page 620*).

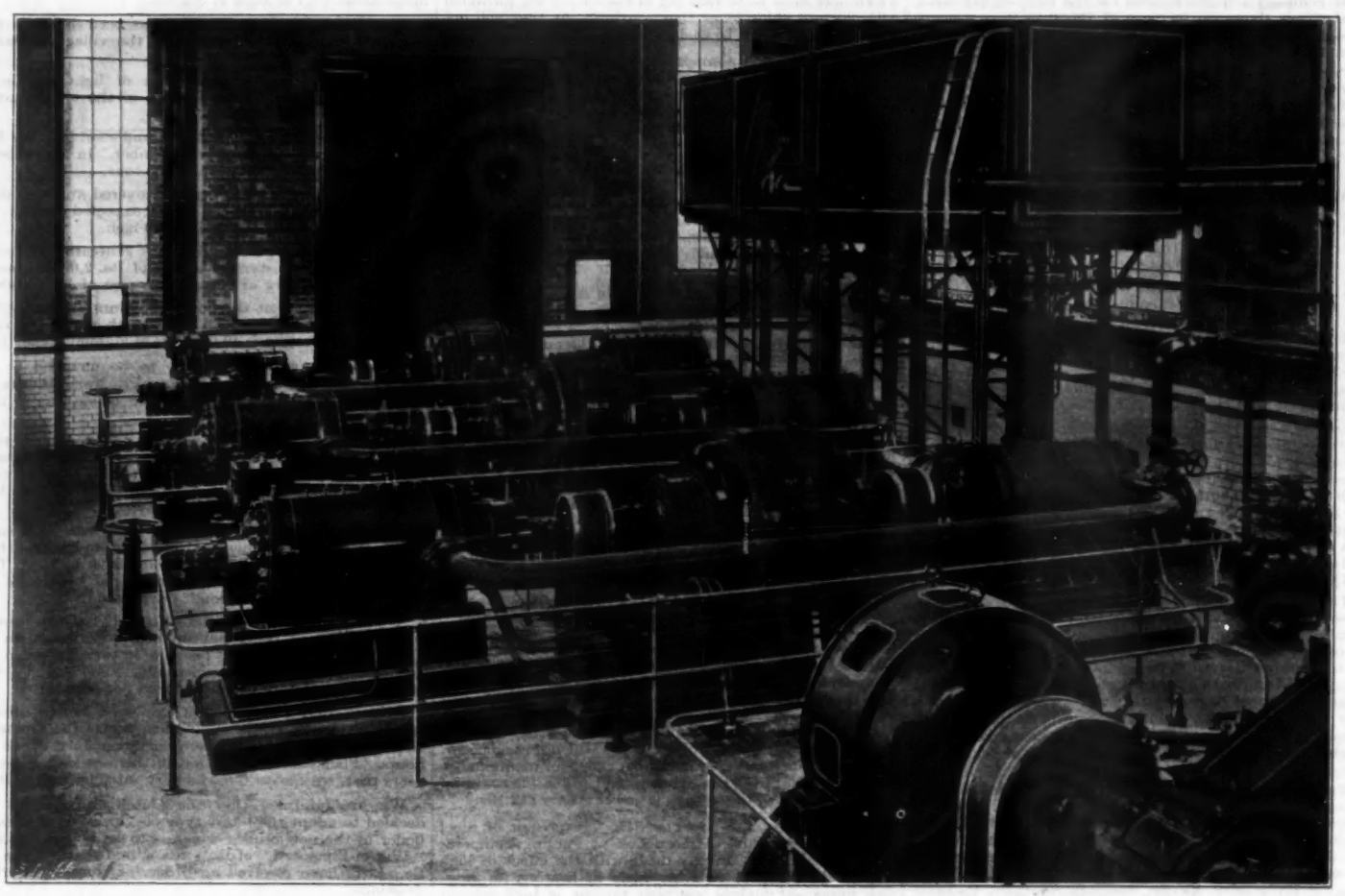

FIG. 1—THE CENTRIFUGAL PUMPING PLANT

FIG. 2—CONTROL PLATFORM

The Engineer

DECEMBER 16, 1932.

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FOREIGN TRADE ORGANISATION.

WHEN representatives from different countries gather together to discuss what shall be done to avoid sliding into an abyss of economic disaster they provide abundant elements to enable one to gauge the extent of the threatened danger. Pessimism is excusable when those who suffer from an unparalleled slump darken the picture in order to impress upon others, less unfortunate, the necessity of immediate action. But even without exaggeration the situation on the Continent is sufficiently serious, for crises are generating crises and threatening the economic downfall of Europe. Delay in providing remedies increases the danger. It was with a view to discuss cures and formulate a policy that would help the Government to define its attitude at the forthcoming World Economic Conference that a Congrès des Industries et Commerces d'Exportation sat in Paris throughout last week. It was national in character, but economists from many countries were invited to take part in the deliberations. Words were not spared to describe the situation in Europe, and the President of one section declared that some way out of the difficulty must be found before the Congress closed, or "Europe would lapse into a state of barbarism." A delegate from Rumania, when describing the situation in Eastern Europe, indicated where that barbarism was likely to come from.

Apart from the negotiations now proceeding between France and Germany for a treaty of commerce in conformity with the changed economic conditions nothing has been done on the Continent to solve a very grave problem, except the Ouchy convention between Belgium, Holland, and Luxemburg for a progressive reduction of import duties. In 1927 at Geneva all the countries, with hardly an exception, agreed to a policy of gradually reducing tariffs. Soon afterwards they all expressed their sense of unanimity by raising their import duties! In face of this inextricable situation the only clearly defined policy is that pursued by Great Britain in negotiating treaties with Scandinavian countries that have left the gold standard. Countries that adhere to sterling offer normal trading conditions amongst themselves, and they happen to be complementary to Great Britain as markets for her goods. The widening gap between them and the gold countries was made clear at the Congress, where the malady from which Europe suffers was regarded as arising mainly from the extreme variations of currencies and values, which, on the one hand, lead to restrictive import measures and, on the other hand, lessen the purchasing power of countries that depend on exports. Obviously, therefore, so long as it is impossible to revert to a general gold standard the only immediate solution is to group those countries that have thrown in their lot with sterling until such time as the gold countries shall have found a way out of their own difficulties. The French, naturally, look with disfavour upon the grouping of any interests outside the gold countries. They are fighting to maintain the gold standard, and declare that a permanent organisation is impossible on any other basis. How, then, does the Congress propose to effect a rational organisation of European economy? There is, first, the influence of cartels as a regulator of production and prices. According to Monsieur Lambert-Ribot, representing the Comité des Forges, the cartel system has proved its value by economising production, reducing costs, and maintaining prices at a reasonable level; it allows of many different combinations to suit particular cases. Nevertheless, national cartels have the effect of adjusting prices at home and intensifying competition abroad, wherefore international action is necessary. It is, moreover, shown that cartels are created in times of prosperity and often become inoperative or break down during periods of depression, largely through the competition of a small percentage of producers who remain outside. If the cartels are to be a factor in international trade the State is regarded as being alone able to ensure that outsiders are forcibly brought within the organisation and are subjected to the same discipline as other members. But the Congress was unable to suggest any means whereby the State could exercise that compulsion. The most important cartel of all, that of steel, is paralysed by the abstention of one Belgian producer, who refuses to alienate his liberty to do as he pleases. So long as the cartels are conducted with moderation they can become powerful instruments for good, but without unanimity amongst producers they are an unreliable factor in international trade organisations. Much also was expected from arrangements by particular industries for an interchange of goods between different countries, but the Paris Congress was not convinced that the system would work satisfactorily as a means of promoting foreign exchanges. Excluding these tried methods of stabilising trade conditions, the Congress was powerless to offer any concrete remedy for a state of things that is inextricably complicated by a series of factors that destroy all attempts to reach a settlement. Numerous papers were read covering the whole range of production, exchanges, and finance, and they served to show that considerable data are yet required to reveal accurately the economic situation of the Continent and provide a basis for elaborating a practical general organisation. The Congress began on a note of immediate action, and then drifted into a maze of difficulties which left it with no alternative but to give expression to general principles. The character of these principles is sufficiently marked to show how Continental countries seek to adapt themselves to the new economic conditions. The French were the originators of quotas, super-taxes on depreciated currencies, taxes on imports, and other expedients, which have turned to their disadvantage through retaliatory measures imposed by other countries. They recognise the failure of those expedients as a general policy, while affirming that they serve their purpose as an emergency measure to prevent the collapse of home industries under very trying circumstances. Those quotas and taxes will go as soon as they can be replaced by an acceptable and durable means of stimulating foreign exchanges, though some quotas may still exist by mutual agreement where necessary between countries. The new policy is based upon strict reciprocity, for which reason France will have nothing more to do with the most-favoured-nation clause when existing treaties are replaced by others. She wants a free hand to negotiate with countries or groups of countries according to what they can offer and take in exchange. The idea of grouping countries with a similarity of products is specially favoured. The treaties then entered into may be revised at stated periods.

All this, of course, implies a maintenance of tariffs which, in the minds of exporters, will be exclusively of a nature to adjust prime costs to a level with those in countries where costs are lower, though it is probable that a good deal of elasticity will be given to an interpretation of the disparity in costs. On some of the recommendations foreign delegates were not in agreement with the French, notably the Free Trade group, but these were inclined to accept the French views on condition that a moderate tariff would be susceptible to a progressive reduction. The recommendations were numerous, and covered practically every aspect of foreign trade. The main difficulty experienced by the French is that at almost every turn they find themselves hampered by depreciated currencies. If many other countries left the gold standard the French plans would fall to the ground. Hence, one of the most important questions discussed was the financial, and industrial and commercial necessities urge the French to fight more vigorously for the maintenance of gold, to the extent that the Congress recommended the use of the French franc as a standard for international exchanges. The French are attempting to do too much, and are doing little, while the British are, at least, making definite progress in regaining markets.

Electric Heating.

Two long discussions from which, as is more or less usual, no very definite conclusions could be drawn, followed a paper on "The Relative Fuel Economy of Electricity, Gas, Oil and Solid Fuel as Heating Agents," read by Mr. A. H. Barker before the I.E.E. at the beginning of this month. With architects and others outside the electrical industry present, the discussions, naturally, did not show an entire preference for electricity, although the opposition to it was certainly very much less pronounced than it has been in the past. When Mr. Grierson read his I.E.E. paper on "The Electrical Heating of Buildings" last year, one speaker expressed the view that the idea of using electricity for heating large civic and municipal buildings, offices, schools, hotels, &c., was nonsensical, whilst another produced figures to show that actual tests had indicated that the cost of electrically heating a large building in Stockholm with current at 0·67d. per unit and with all the alleged advantages of electricity taken into account, was three and a-half times as great as it was with the central warm-water system. But electrical heating engineers contend that with modern methods of heating large buildings electrically, very different results can be secured. The post-war period, they explain, has seen a rapid advance in the development of more suitable apparatus, and marked reductions in the tariffs of many supply undertakings. Nevertheless, the fact remains that the apparent disadvantage of electricity is that the heat into which it can be converted is much more expensive per B.Th.U. than that derived from other sources, and until those who believe in this method of heating can convince everyone that, when all things are taken into account, this is really a matter of no importance, the system is not likely to make great progress.

Against this relative high cost of the B.Th.U's electrical engineers set the avoidance of waste associated with alternative systems and other advantages, such as instantaneous control and cleanliness; but, up to the present, they only seem to have convinced a very few people that electricity is the right medium for heating large buildings. While these engineers invariably emphasise the immense public importance of abolishing the smoke nuisance arising from domestic fires, &c., they rarely appear to realise that the emissions from the chimneys of power stations can also prove very objectionable. On paper some of the arguments in favour of electric heating on a large scale look very well, but they would be more convincing if they were backed by actual practical results. If, for example, Mr. Barker had cited cases where a change from any ordinary method of heating to electric heating in large buildings had resulted in a saving of money, or had even proved no more expensive than the original system, his paper would have been better appreciated. Still, judging from the remarks of some speakers, it is to be regarded as a useful contribution to the literature on the subject. Briefly, the paper is an effort to explain the reason why, and the conditions under which, electricity can be used competitively for the heating of buildings, notwithstanding that the cost of the crude heat is several times greater than that of other heating media. But the cost of fuel and the labour involved are alone considered, and no attention is paid to the capital cost and allied matters; hence, it is scarcely to be wondered at that no attempt has been made to compare the total costs of specific installations. Heat generated in a central boiler-house is shown to be frittered away during its journey to the

rooms where it is required. On the other hand, it is explained, an amount of heat fully equivalent to the energy of the electric current can be delivered at the exact time when it is required, thereby avoiding the waste caused by the lack of accurate timing associated with all systems in which heat is distributed from a central boiler, irrespective of whether it is electrically or otherwise heated. A close comparison is made between the features of electricity and gas as heating agents, and between the operating characteristics of oil and coke. The labour involved in handling the fuels in each case is also considered in detail. Intermittent heating is shown to be more economical than continuous heating, and instantaneous control, as obtainable with electricity, is claimed to be of great importance in restricting the unnecessary use of heat, whilst, at the same time, supplying an adequate amount for maintaining comfortable conditions during all times of actual occupation. Tables and diagrams show the progressive loss of heat in the various stages through which it passes, and explanations are given of the calculations of the heat quantities necessary for maintaining the required temperature, as well as the proportions inevitably dissipated in the process of delivering heat from a central point to the rooms. Finally, there is a table in which, assuming fixed prices for the crude heat, average medium values for the various factors involved, and theoretical perfection of the heating result for an assumed period, the relative annual cost of heating 1000 cubic feet of average space for the various media, is calculated. Although at least one speaker seemed to have lost sight of the fact the author takes particular pains to point out that the table represents relative and not absolute values, and that it is easy to alter it in any proportion. If, for example, electric power is purchased at 1d. per unit instead of ½d., all the figures of cost in respect of electrical power will be immediately doubled.

Obviously, the author's aim is not to prove that electric heating is advantageous under all conditions, but rather to provide means whereby the relative costs so far as fuel and labour are concerned can be calculated. At the same time, he undoubtedly believes that the application of electricity to the heating of large buildings is justifiable in many cases. In the relatively few instances in which electricity has been employed in this connection, he explains, the somewhat startling fact has been discovered that the total amount of electrical energy actually delivered into the building in an entire year expressed in B.Th.U's has been less, and in some cases very much less, than that which would have been necessary with hot water heating, notwithstanding that the buildings have been satisfactorily warmed at all times of occupation. But no one who took part in the discussion supported this statement by the production of figures of relative total costs based on actual experience. The discussion covered many aspects of the subject, some of which were scarcely relevant to the paper, such, for instance, as the liking some people have for the cosy coal fire, the unsatisfactory ventilating properties of electric radiators, and so forth. When engineers write papers based on long investigations and introduce complications and ramifications which they alone can readily understand, the discussions are generally unsatisfactory. Speakers pick upon a few sentences which they can follow and neglect the more difficult parts, with the result that when the meeting is over, the main substance of the paper has not been discussed at all. Even Mr. H. Hobson, who has been engaged on the troublesome task of framing the two recently issued grid tariffs, contented himself by calling attention to possible errors in the author's results. The paper, he said, was built up step by step by such a very complicated series of calculations that he was left with a rather uncomfortable feeling that, through the possibility of the multiplication of errors, conclusions might have been arrived at which contained errors of such a magnitude as to violate entirely the ratios which the author had said were average and general, rather than specific. Against this criticism, however, must be set the statement by Mr. E. M. Young, who explained that his experience confirmed the accuracy of the type of calculations used by the author. Towards the end of the second meeting Mr. J. Lesser attacked the paper with considerable vigour, whilst a subsequent speaker praised it. What opinion, if any, the architects and general heating engineers formed from the two discussions we have no idea, but it is not improbable that many who attended both meetings finally left with their minds a little confused.

Emission of Dust from Power Station Chimneys.

IN June, 1930, the Electricity Commissioners appointed a committee "to consider and report upon the measures which have been taken, both in this country and in others, to obviate the emission of soot, ash, grit and gritty particles from the chimneys of electric power stations." The committee, presided over by Mr. C. D. Taite, appointed a technical sub-committee, which began its work by dealing with power station practice in this country. Having completed its survey of the position at home, the sub-committee, in May, 1931, visited some twenty power stations and works in Germany and France, and studied the manner in which they had overcome their difficulties connected with the discharge of dust and grit. The sub-committee submitted a draft report to the main committee, which, after certain modifications had been made to it, was submitted to the Commissioners. The report as finally presented was published on Wednesday of this week, and from several points of view must be regarded as a highly important and valuable document.

In general the Committee considers that it has been conclusively proved that dust emissions from power station chimneys can be prevented by practicable means. Provided the recommendations which it makes in its report are adopted, the creation of a dust nuisance in the case of new generating stations will, it holds, be avoided, although it adds that it may not be possible because of engineering or other difficulties to give full effect to the recommendations in all existing stations. For pulverised fuel-fired installations it asserts that the electro-static precipitator is the most suitable type of dust extraction plant, and that the use of water for dust-extraction purposes has certain disadvantages and is not to be recommended. For stoker-fired installations, no dust-extraction plant will be necessary if certain conditions of design and operation are observed; but if these conditions do not exist the multi-cyclone type of dust-extraction plant will be found to be suitable. The Committee also holds that there is an urgent need for the standardisation of some reliable method of testing the efficiency of dust-extraction plant and the grading of dust. It urges, in addition, that the minimum height of chimneys should be two and a-half times the height of the highest point of the generating station buildings plus an allowance where necessary for local conditions. It argues that many of the difficulties which have recently been met in connection with emissions from generating station chimneys would have been avoided if high chimneys had been generally adopted.

Reviewing existing practice in Great Britain the Committee found that out of 111 "selected" stations under the grid schemes, 51 have found it unnecessary to install any form of grit-extraction plant. Out of the 94 stoker-fired installations included in this total, 45 employ the cyclone type of extraction plant, 1 employs a combined cyclone and wet type, and 48 use no form of extraction plant. The remaining 17 stations are fired with pulverised fuel. Of them, 8 use cyclone plants, 3 combined cyclone and wet plants, 2 wet plants, 1 uses the electro-static system, and 3 employ no form of extraction plant. In Germany the Sub-committee visited three stoker-fired installations, and found that two were employing electro-static precipitators, while the third had no system of dust extraction. It also visited in that country 14 pulverised fuel-fired installations. Three of these stations were found to be using combined cyclone and wet plants, 4 wet plants and 4 electro-static plants. The remaining 3 had not installed any form of extraction plant. In France the Sub-committee visited only 3 stations. At one, electro-static precipitators were in use and were, apparently, giving satisfaction. At another a wet system was being installed. At the third, a wet type of plant and also an experimental electro-static precipitator were installed, but the electro-static plant was unsatisfactory and was out of commission.

The emission of grit with pulverised fuel is, undoubtedly, considerably greater than with stoker-fired plant. According to the report, a stoker-fired plant burning fuel with 12 per cent. ash content might pass 10 per cent. of the ash in the fuel to the chimney. A pulverised fuel plant using the same fuel might pass to the chimney 70 per cent. of the ash. These figures correspond approximately to a grit concentration of 0·3 grains per cubic foot for the stoker plant, and 2·62 grains per cubic foot for the pulverised fuel plant. The grit held in suspension in the gases may, roughly, be divided into cinders, grit and fly ash, the three grades, collectively, being called dust.

The grading of dust, the report points out, has previously been almost wholly carried out by means of sieves, the standard sieves in this country being those of the Institute of Mining and Metallurgy. The Committee considers that the grading of dust by means of sieves is entirely unsatisfactory, because it is unreliable if the particles are less than 63 microns (0·063 mm.) in diameter, because it is impossible if the particles are less than 43 microns in diameter, and because the important factor is the specific gravity or buoyancy of the particles rather than their diameter. It, therefore, recommends that some form of water or air elutriator—preferably the air type—should be adopted for standardisation purposes, and that a unit should be evolved by which the grading of dust could be expressed in terms of its rate of fall in still air.

Average figures for the dust in flue gases from pulverised fuel plants are given in the report as follows:—

Grading of dust.	Percentage.
Larger than 120 microns	1·5
Between 120–75 microns	7·0
" 75–43 "	12·0
" 43–20 "	29·0
" 20–10 "	26·5
Less than 10 microns	24·0

It is generally agreed, the Committee says, that particles of 20 microns and less cannot be classified as dust, but belong to the category of cloud or fume particles. Such particles even in still air may remain in suspension almost indefinitely. The problem before the designer of dust-elimination plant is therefore, to obtain as nearly as possible 100 per cent. efficiency on all particles above 20 microns and to extract such proportion of the particles below this size as the capacity of the station and the percentage of such small-sized particles in the flue dust may render desirable. In no case, the Committee holds, should the overall efficiency of the plant be less than 85 per cent. A test carried out on a modern electro-static plant showed that it had an overall efficiency of 90 per cent. On all sizes over 30 microns its efficiency was 98 per cent., and on the sizes below 30 microns 85·6 per cent.

Evidence submitted to the Sub-committee is held to prove that special dust-extraction plant is unnecessary with stoker-fired installations if the flue gas velocity is low and the chimney is high, and if the fuel has a low ash content. With high gas velocities and high rates of combustion, however, it is necessary, even in stoker-fired installations, to use dust-extraction plant.

Variation in the loading of the boiler and the use of soot blowers have to be considered as regards their effect on the emission of dust. Soot blowing considerably increases the concentration of dust in flue gases. Similarly, there will be an increased concentration if the boiler duty is increased for such increased duty calls for an increase in the velocity of the gases through the boiler passes and the flues. This increased gas velocity prevents the settlement of dust which would take place at lower velocities and will lead to the entrainment of the dust previously deposited at lower duties. The report expresses the view that insufficient attention has been given to reducing the amount of dust which settles on the heating surfaces and to the immediate removal of the dust which settles in the flues, or, alternatively, to its deposition outside the influence of the flue gases. The Committee also considers that soot blowers are not always situated to the best advantage, and that they should be used more frequently than they generally are used. If these points are attended to, it is held that dust extraction plant can be installed on a commercial basis, which will be capable of preventing a dust nuisance under any conditions, including soot blowing. In existing plant, soot blowing can be carried out without overtaxing the dust extraction equipment, if it is carried out frequently, and if the volume and therefore the velocity of the flue gases is reduced during the blowing process. If the dust extraction plant is of the cyclone or centrifugal type, best results will be obtained by running the induced draught fan at full speed during the soot-blowing process.

A considerable amount of attention was devoted by the Sub-committee to the question of testing the efficiency of dust-extraction plants. Various methods, it was found, were in use, but very few of them were even approximately reliable. It is pointed out that it is not sufficient to determine merely the percentage of the dust held back by the extractor, but that the grading of the dust presented to and passed by the extractor should also be determined. For example, even with a plant of high overall efficiency, the dust which passes the extractor may consist of sufficient large particles to constitute a nuisance.

One method of calculating the dust emitted from a chimney is to determine by analysis the weight of ash in the coal burnt and to deduct from this figure the weight of ash and dust left in the boiler and extraction plant. This method is held by the Committee to be unreliable, because the usual laboratory method of determining the ash content of a fuel is to subject it to a temperature of 800 deg. Cent. for a given period, and to weigh the residue. In a boiler furnace the temperature is in the region of 1600 deg., and the period of combustion is probably quite different. Under these service conditions a lower weight of ash is produced than under the conditions of a laboratory test. The difference varies with different coals, and may be as low as 0·6 per cent. or as high as 12 per cent. It is apparently caused by the dissociation of the sulphates present in the ash.

The only satisfactory method of testing the efficiency of dust-extraction plant is, it is held, to measure the weight of dust in the gases before and after they pass through the extractor or one or other of these weights, together with the weight of dust caught by the extractor. The usual method of determining the concentration of dust in flue gases is to draw off continuously a sample of gas through a filter, to weigh the dust deposited on the filter, and to measure the volume of the gas drawn off. The report enters at

some length into the various precautions which must be taken in order that the results obtained in this way may not be misleading. Descriptions are given of various forms of filter and of the testing methods associated with them, as found in this country and Germany, but the Committee's general conclusion is that further investigation is necessary before an entirely satisfactory system, which might be recommended for adoption as standard, can be established. Two German methods are commented upon favourably. In one a large sample of the flue gas is drawn off by a vacuum pump through a cyclone, in which the bulk of the dust is deposited before the gas reaches the filtering medium. In another as many as eight small filters are employed simultaneously. These filters are placed in a row across the flue and are gradually moved across the flue area, samples of the gas being drawn through each filter in each of its positions.

Describing the better-known forms of dust-extraction plant, the Committee divides them into wet and dry categories. In the wet class there are the water film and the water spray types, and a form in which water films and sprays are combined. The dry systems comprise cyclones and electrostatic precipitators.

In the water film system the gases are brought into contact with surfaces covered with a thin film of water, to which the dust particles adhere. The water is not sprayed or atomised, and it is claimed that the system does not saturate the gases with moisture. Plants operating with water sprays subject the gases to a spray of water divided as finely as possible. It is asserted that this method of working saturates the gases to such an extent that in many cases a water arrester is necessary before the gases can be allowed to pass to the chimney. In combined film and spray plants the gases are passed first through a spraying system, and then through a film arrester. It is claimed for this type that the gases are not emitted from the chimney in a saturated condition. In all these wet methods of dust extraction it is necessary to reclaim the solids from the effluent and in some cases to treat the recovered water before it can be disposed of or used again for washing purposes. The usual method of reclaiming the solids is to pass the effluent to settling tanks, of which there must be at least two. The Committee does not consider this method of treatment as being satisfactory. The best method which it inspected was, it holds, one in which an automatic slurry thickener was combined with a rotary filter.

The Committee agrees that dust extraction can be satisfactorily carried out by means of a properly designed "wet" system, but it argues that the use of water solely for the purpose of extracting dust is open to a number of objections. Serious corrosion may occur unless the chimneys are provided with an acid-proof lining, and all iron and steel parts exposed to the wet gases are protected. There may be difficulties in the way of obtaining an adequate supply of water, and in this connection it is noted that salt water increases the risk of corrosion. The disposal or filtering of the effluent and the site occupied by the settling tanks are other objections. In some cases it may be necessary to neutralise the recovered water before disposing of it. Further, the cooling of the gases in the chimney causes loss of draught, and with certain classes of coal trouble may be caused by the caking and building up of the dust in the flues and extraction plant. Finally, precautions must be taken to prevent the possibility of water particles being emitted from the chimneys.

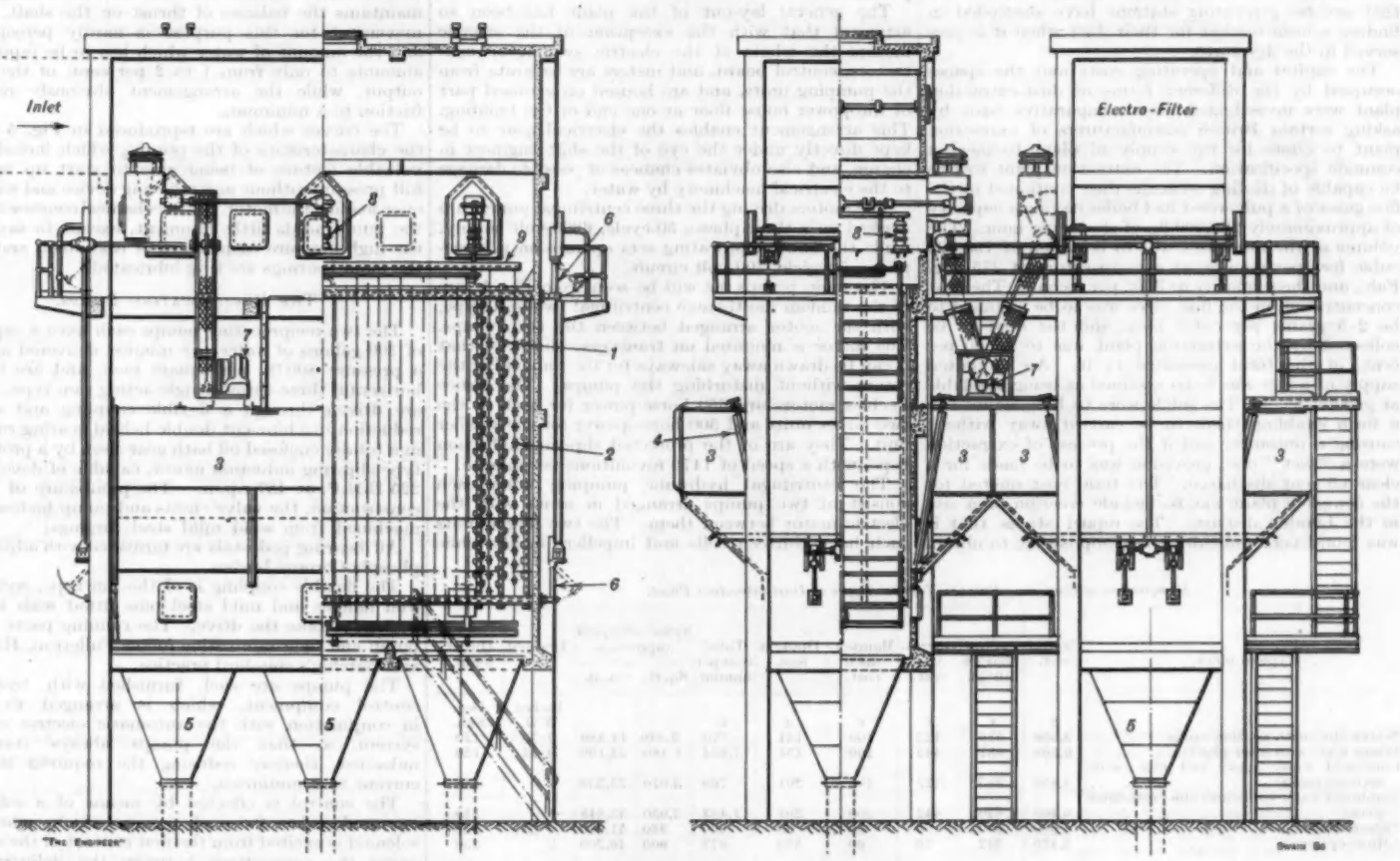
Of the dry systems, the first described by the Committee is the cyclone. This plant depends upon centrifugal force for the separation of the dust from the gases, and in order to create the necessary force a high velocity is needed which, in the Committee's view, is costly in fan power. Since the efficiency of the cyclone depends upon the velocity of the flue gases, the system is necessarily less efficient at low boiler loads when the flue gas volume is reduced than at high boiler loads. To meet this feature, a multiple cyclone has been developed, in which a number of cyclones are connected together in parallel, the number in use being varied according to the loading of the boiler. In the Committee's considered opinion, the single cyclone type of extraction plant is reasonably efficient when dealing with dust above 40 microns in diameter, but with dust of less size its efficiency falls away to an extent such as to render the system unsuitable for use on pulverised fuel-fired installations.

The following description of the electrostatic type of precipitation plant is taken verbatim from the report :—

Electrical precipitation was first applied practically by Sir Oliver Lodge, and is now widely used for precipitating dusts and mists out of gases. The gas is made to pass through pipes or between plates known as the collector electrodes. These are earthed and receive the dust or mist which is extracted from the gas. Down the centre of the pipes, or in between the plates, is placed a series of discharge electrodes, which may consist of wires or rods with discharge points, which are maintained at a high negative potential of the order of 60/70,000 volts. As a result, a brush discharge takes place, and the wires can be observed to glow, being surrounded by a corona. Every solid and liquid particle in the gas becomes ionised, and these charged particles are now in the field which exists between the negative or discharge electrodes, and the positive or collector electrodes, which are connected to earth. The particles therefore migrate towards the collector electrodes and thereupon give up their charge. The discharged particles may fall by gravity into the hoppers below, or if they tend to adhere the collector plates are rapped from time to time by hammer gear, whereupon the dust slides off and is ultimately caught in the hoppers.

Various forms of treaters and electrodes are used for different purposes, and the design is modified in different ways to meet the wide range of gases and varying conditions of temperature, moisture content, nature of dust, &c., that are dealt with in electrostatic precipitators. Pulverised fuel dust in particular, owing to its extreme fineness, presents special features. In addition, complications arise if it is necessary to add an electrostatic preciptator to an existing installation, as there are problems of space and runs of flue which are bound to modify the design.

Figs. 1 and 2 show a twin unit, consisting of two towers arranged so that one tower can be shut off for inspection whilst the whole of the gases is passed through the remaining tower. The gases pass vertically downwards between the collector electrodes 1, which consist of a series of plates furnished with catch pockets, as indicated, a patented form of construction which has been specially designed for fly ash. The gas, after passing to the bottom of the collector plates, is allowed to escape from both sides of each tower into four parallel exit flues 3. Dampers 4 are provided to equalise the flow, so that each of the three sections of each tower deals with its own share of the gas. There are three hoppers 5 for each tower. The dust is precipitated on to the collector plates, and when it has given up its charge the bulk of the dust falls into the hoppers by gravity. To assist this action and prevent any accumulations of dust adhering to the plates, a system of rapping hammers is provided to vibrate periodically the plates. These hammers, driven by an electric motor 7, operate at both ends of each tower, as shown at 6. The discharge electrodes 2 are a specially patented design, consisting of rods with discharge points. They are supported between high-tension frames 9 carried on large enclosed insulators 8.



TYPICAL ELECTRO-STATIC FLUE-DUST COLLECTOR

The necessary high negative voltage, which is obtained from a special transformer set housed in a separate building, is rectified by a synchronous motor rectifier. The equipment is controlled from an enclosed type low-tension switchboard. The high-tension gear is housed behind a safety screen closed by a safety door, so that no access to the high voltage is possible. Automatic gear is also provided with an audible signal to call attention should anything occur to upset the normal operation of the plant. The dust collector is designed to function continuously without any regular attention. The power consumption of such plants amounts to about 2 kWH per million cubic feet of gas cleaned. Back pressure through such a plant depends to some extent upon the arrangement of the flues, but in the plant itself the loss is usually about ½in. w.g. There is no loss of heat except by conduction through the shell of the filter, which is built of reinforced concrete. Thus the gases pass to the stack with very little drop of temperature. The natural draught is maintained and there is no risk of condensation occurring. The dust is delivered dry and in very fine particles. The size and disposition of the units can be varied very widely to meet the various conditions at site. They can be placed either on ground level, or, if incorporated in the original design, they can be placed in the top boiler-house to minimise the length of flues necessary.

Summing up the merits of the electrostatic process, the Committee designates as advantages the facts that the flue gases do not come into contact with

water, that there is no loss of heat in the flue gases except by conduction through the casing, that the loss of draught is negligible, that the auxiliary power consumption is low, that the maintenance costs are slight, and that the dust is collected dry and can be removed either in the dry or wet state. The disadvantages are stated to be threefold. The efficiency is not maintained if the gas velocity exceeds that for which the plant is designed. The space occupied is large compared with that required for the wet system. The rapping gear has in the past been a source of mechanical difficulty, although it is understood that recent developments have remedied the trouble.

The disposal of the dust caught in extraction plant often presents difficulties. The general practice, the Committee notes, is to dump it on a suitable site as near as possible to the station. If the dust is dry, it may create a nuisance when in transit to the dump, and afterwards at the dump itself. For this reason a water system of withdrawing the dust from the hoppers of the extraction plant has been introduced, the resulting slurry being discharged into the water system of ash handling, which is now in general use. At one station visited by the Sub-committee the very fine dust caught in an electrostatic precipitator was drawn off from the hoppers into paper bags. The possibilities of this system of disposal seem to the Committee to be worthy of investigation. It is noted that several generating stations have succeeded in finding a local market for their dust when it is preserved in the dry state.

The capital and operating costs and the spaces occupied by the different forms of dust-extraction plant were investigated on a comparative basis by asking certain British manufacturers of extraction plant to quote for the supply of plant to meet a common specification. The extraction plant was to be capable of dealing with the dust contained in the flue gases of a pulverised fuel boiler having a capacity of approximately 200,000 lb. of steam per hour. The volume of the flue gases was to be taken at 100,000 cubic feet per minute, at a temperature of 275 deg. Fah., and their velocity at 30ft. per second. The dust concentration in the flue gases was to be assumed to be 2·5 grains per cubic foot, and the dust to be collected by the extraction plant was to be 90 per cent. of the total presented to it. An unlimited supply of water was to be assumed as being available at ground level. The solids were to be reclaimed in a form enabling them to be carried away without causing a nuisance, and if the process of extraction were a "wet" one, provision was to be made for a clear effluent discharge. The total cost quoted for the complete plant was to include erection on a site in the London district. The report states that it was found very difficult, if not impossible, to obtain an absolutely fair comparison as to the cost of the different forms of plant, but a fair idea of the expense involved in each case is presented in the table above.

Comparison of Cost, &c., Between Various Types of Dust-extraction Plant.

Type of plant.	Capital cost.	Capital charges (10%).	Operating cost.	Maintenance cost.	Draught loss.	Total cost per annum.	Space occupied (approx.). Sq. ft.	Space occupied (approx.). Cu. ft.	Draught loss.	Outlet temp.
	£	£	£	£	£	£			Inches W.G.	Deg. Fah.
Water film (with settling tanks)	3,358	336	123	100	151	710	2,440	14,880	0·75	120
Water film (with filter plant)	6,308	631	442	200	151	1,424	1,480	23,190	0·75	120
Combined water spray and film (with settling tanks)	3,450	345	123	100	201	769	3,010	25,338	1	140
Combined water spray and film (with filter plant)	6,400	640	442	200	201	1,483	2,050	33,648	1	140
*Electrostatic	6,000	600	190	50	50	900	980	41,000	0·25	250
*Multi-cyclone	3,420	342	75	60	395	873	900	46,200	2	250

Notes.—The figures in this table are based on actual figures given by the contractors, and are only intended as a basis of comparison between types of plant.

The general opinion of the fan manufacturers, formed after extensive experience, is that the fans should deal with the clean gases. This is, however, only possible with "dry" type dust extraction plant, as in "wet" types it is found that corrosion due to wet gases is a greater source of trouble than erosion from the dust. For the purposes of the above table, therefore, it is assumed that the fan is placed on the outlet side of the "dry" types of extraction plant, and on the inlet side of the "wet" types.

It is assumed that the plant operates for twenty-four hours per day, 300 days per annum, and wages are taken as 60s. per man per week.

The power for operating the plant and fans is based on a charge of 0·25d. per unit. The additional fan power required to overcome the resistance of the plant is dealt with under "Draught Loss."

* These figures do not allow for cost of dealing with the dust after leaving the dust extraction plant hoppers.

A New Hydraulic Power Station at Leith.

In the article which follows we describe the new hydraulic power plant at the Imperial Dock, Leith, which has been supplied and erected to the specification of Mr. A. H. Roberts, M. Inst. C.E., superintendent and engineer, and Mr. J. Dalgleish Easton, M. Inst. C.E., for the Leith Dock Commission by the Pulsometer Engineering Company, Ltd., of Reading, London, and Glasgow, with the co-operation of Fullerton, Hodgart and Barclay, Ltd., of Paisley. The general lay-out of the pumping station and the electrical controls and switchgear is shown in Fig. 3, and on page 616 we reproduce two views, Figs. 1 and 2, in the station itself.

The Pumping Plant.

It was originally intended to erect a small boosting station, comprising two reciprocating pumping units, to supply additional power for new coaling plant. After, however, the orders for the small station had been placed, and following on suggestions from the Unemployment Grants Committee, the Commissioners decided, in view of the greater efficiency and economy thereby secured, to erect a complete central hydraulic power station to supersede the existing steam stations which have been in use up to the present. The two reciprocating pumping units were therefore incorporated in the scheme.

The pumping plant installed is electrically driven, and comprises five pumping units working against an accumulator pressure of 800 lb. per square inch. Three of the pumps are of the multi-stage centrifugal type, made by the Pulsometer Engineering Company, Ltd., of Reading, two having a capacity of 800 gallons per minute and one of 600 gallons per minute. The remaining two units are of the reciprocating type made by Fullerton, Hodgart and Barclay, Ltd., of Paisley, each of a capacity of 300 gallons per minute. The electric motors installed in the power house have a total capacity of 2067 horse-power. As indicated by Fig. 3, the pump house is built with a deep basement, so that all piping and electric cables are placed below the power house floor, and are readily got at for repairs and inspection. A 5-ton overhead travelling gantry crane, designed to travel the whole length of the house, is also provided.

The general lay-out of the plant has been so arranged that with the exception of the electric motors the whole of the electric switchgear contactors, control board, and meters are separate from the pumping units, and are housed on a raised part of the power house floor at one end of the building. This arrangement enables the electrical gear to be kept directly under the eye of the shift engineer in charge, and also obviates chances of possible damage to the electrical machinery by water.

The motors driving the three centrifugal pumps are worked on a three-phase, 50-cycle, 6600-volt supply, while the two reciprocating sets operate on a three-phase, 50-cycle, 400-volt circuit.

The main pumps, as will be seen from Fig. A, are of the tandem multi-stage centrifugal two-unit type, with the motor arranged between the two pumps. The motor is mounted on transverse slides, so that it can be drawn away sideways for the removal of the rotors without disturbing the pumps. The Bruce Peebles motors are 650 horse-power for each of the two larger units and 500 horse-power for the smaller unit. They are of the protected slip-ring induction type, with a speed of 1470 revolutions per minute.

The centrifugal hydraulic pumping units each consist of two pumps arranged in series with the electric motor between them. The two larger units each have thirteen cells and impellers in all, while the smaller unit has sixteen cells, but of smaller diameter. The units are virtually a series of centrifugal pumps with diffusing chambers in between, which convert the kinetic energy of the water leaving the impellers into pressure energy before it enters the eye of the next impeller. The casing of the pump consists of a number of sections or stages or cells, held together by long bolts between the end covers, which form the suction and delivery chambers respectively. This construction not only eliminates any unseen leakage from cell to cell, but is very convenient when the pump has to be opened out for examination, as there is no difficulty in separating the cells. Alignment is obtained by spigots and recesses in the component parts, and as each cell is provided with feet resting on the bed-plates, there is no difficulty in making the spigots enter the recesses when reassembling. Lugs are provided on the cells for forcing them apart, thereby rendering dismantling rapid and certain.

The diffusers are formed in the main casting, but the guide vanes, tips, and the sides of the diffusers, which are in contact with the high velocity water, are made of a special bronze to resist the action of the water. They are easily renewable, as they are cast on the side of a ring, which forms one wall of the diffuser passage. The stuffing-boxes are fitted with gun-metal bushes, with glands of gun-metal, which are bored sufficiently large to clear the shaft. On the suction side the gland is exposed to the pressure of the first cell only, while that on the delivery side is subject to the pressure on the balance chamber only. In the case of the second unit, however, the gland at the suction end would be subjected to considerable pressure unless precautions were taken to relieve it. Between the stuffing-box and the inlet chamber there is a long sleeve, which has four annular passages. Three of these passages are connected by piping with the diffusers of the three intermediate stages of the low-pressure pump, and the fourth to the suction. The result is that the pressure of the water leaking back through the sleeve towards the gland, and the pressure in the passages referred to above are the same as those existing in the corresponding stages of the L.P. unit. Hence the gland is finally only subject to the pressure existing in the suction side of the first cell of the low-pressure pump.

The end thrust on the shaft of each pump caused by the difference of pressure on the opposite sides of the impellers is taken up by a balancing disc at the delivery end of the pump, which is secured to the shaft, almost in contact with an annular seating, and the intervening space is supplied with pressure water from the last impeller. The water spills away through the clearance between the disc and its seating, and maintains the balance of thrust on the shaft. The movement for this purpose is hardly perceptible, and the amount of water which has to be repumped amounts to only from 1 to 2 per cent. of the total output, while the arrangement obviously reduces friction to a minimum.

The curves which are reproduced in Fig. 5 show the characteristics of the pumps, which include the valuable feature of being able to start up against full pressure without any relieving device and without over-loading the motor. The mechanical construction of the pump needs little comment, except to say that the high-pressure casings are of cast steel, and that the main bearings are ring lubricated.

The Reciprocating Pumps.

The two reciprocating pumps each have a capacity of 300 gallons of water per minute, delivered against a pressure 800 lb. per square inch, and are of the horizontal three-throw, single-acting ram type. They are driven through a flexible coupling and single-reduction machine-cut double-helical gearing running in a totally enclosed oil bath gear case, by a protected type slip-ring induction motor, capable of developing 225 B.H.P. at 487 r.p.m. The pumps are of heavy construction, the valve chests and pump bodies being machined from solid mild steel forgings.

All bearing pedestals are furnished with adjustable phosphor bronze bushes.

The flexible coupling is of the pin type, with cast iron flanges and mild steel pins fitted with leather buffers to take the drive. The running parts of the pump and their lubrication follow Fullerton, Hodgart and Barclay's standard practice.

The pumps are each furnished with hydraulic control equipment, which is arranged to work in conjunction with the automatic electric control system, so that the pumps always start up unloaded, thereby reducing the required starting current to a minimum.

The control is effected by means of a solenoid-operated valve for each pump, which, when the solenoid is excited from the first contact of the starter opens the connections between the delivery and suction side of the pumps so that the water delivered by the rams is by-passed direct to the suction side. The final movement of the starter short circuits the solenoid, so that the by-pass valve is closed and the pump then delivers into the main.

Feed Pumps and Feed Tanks.

Three 6in. centrifugal feed-water pumps are provided and are designed to deliver 2000 gallons of sea water per minute against a total head, including friction of 35ft. The pumps draw water through a separate main from the Imperial Dock and deliver it into a main immediately below the four feed tanks, from which branches are carried up to the upper part of the tanks.

The feed pumps are automatically controlled from floats in two of the tanks, and are directly coupled to motors working on a three-phase, 50-cycle circuit of 400 volts. The four overhead feed tanks, as shown in Fig. 3, are placed along the north wall of the pump house, the underside of the tanks being 10ft. above the pump house floor to give a positive head on the suction inlet of the hydraulic pumps. The four tanks have each a capacity of 3000 gallons, and have each an outlet connected to common suction piping in the basement of the pump house, from which the suction pipes of the hydraulic pumps are supplied with water.

The four tanks are fitted with overflow and wash-out pipes connected to a common drain pipe in the basement of the pump house, which leads the surplus water back to the Imperial Dock. They are interconnected by large pipes, each fitted with a sluice valve arranged so that the water level will be the same in all the tanks which are at work, and it is therefore possible to isolate, when necessary, any one of the tanks for cleaning.

Each pair of tanks is fitted with a water level indicator, and also with a float which actuates tappet switches which cause the electric current to be switched off from the motors driving the hydraulic pumps when the water level approaches the bottom of the tanks, also tappet switches to control two of the feed pumps.

Filtering and Chlorinating Arrangements.

As some of the water used in the appliances round the dock is returned to the feed tank, there is a possible risk that the water may become contaminated after a while from dirt or scale which may have been dislodged from the mains, and from marine growths which may develop. To obviate such a disadvantage, a Pulsometer "Torrent" filter, designed to filter 3000 gallons of water per hour, is placed in the basement below the pump house floor. A 2 B.H.P. electrically-driven pump takes the water from the tank nearest the electric control platform, passes it through the filter, and delivers it back into the tank farthest away from the electric control platform, so that the whole of the water in the tanks is gradually passed through the filters. In order to prevent any development of marine growths in the water, a Wallace and Tiernan chlorinator injects chlorine gas into the water, which is being passed back to the feed tanks.

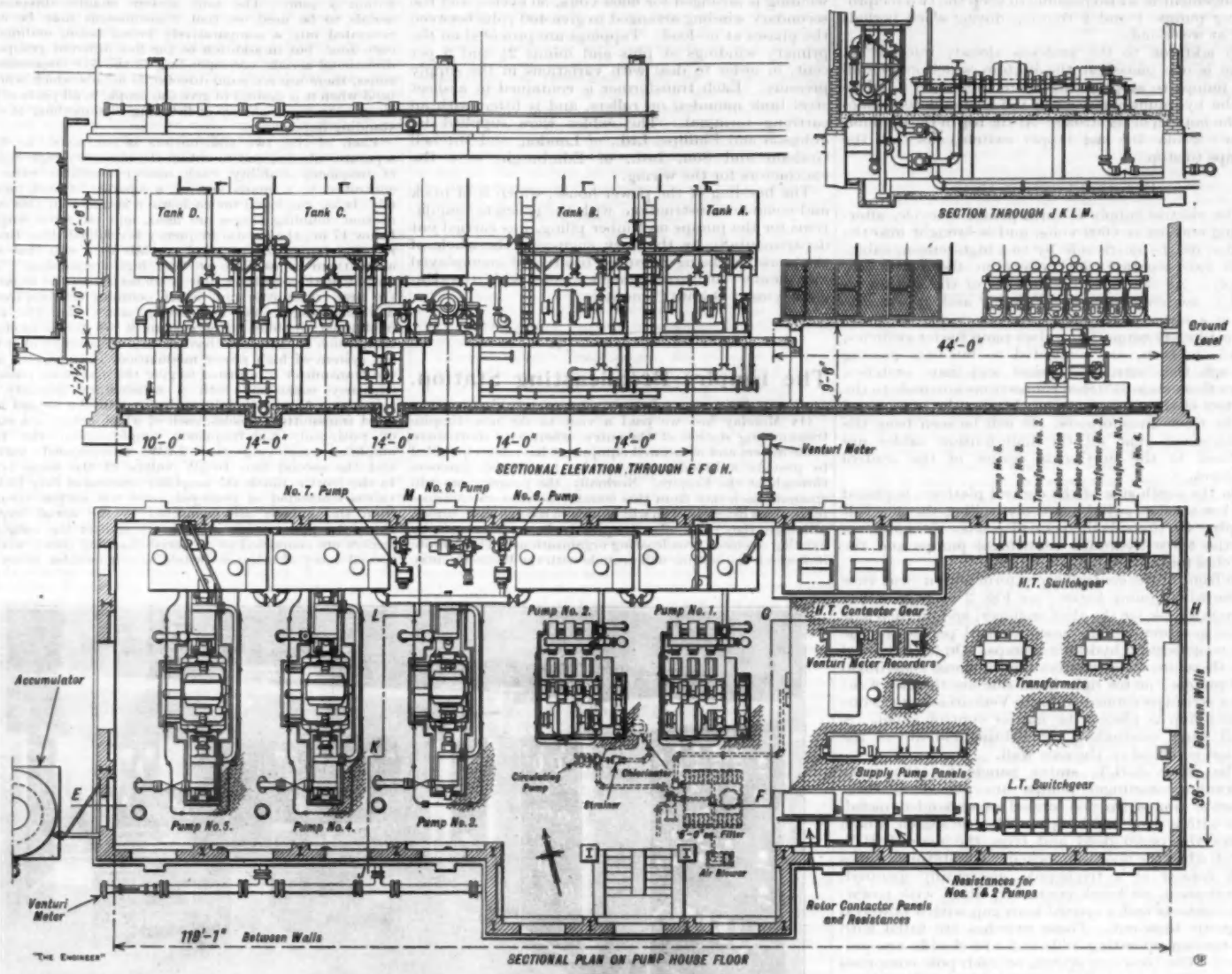
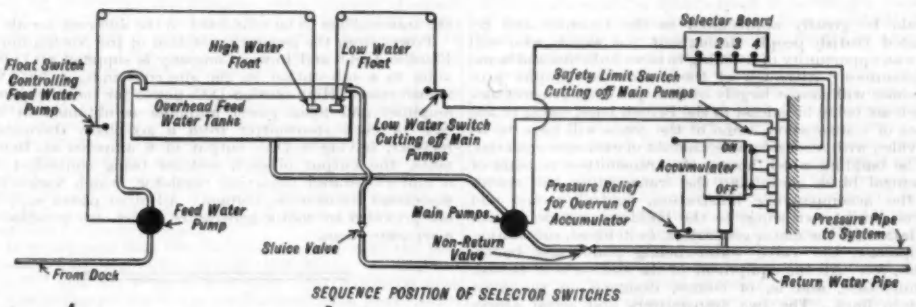


FIG. 3—LAY-OUT OF PUMP HOUSE

Hydraulic Main and Accumulator.

A cast iron hydraulic main with branches to the various pumps passes right through the basement under the pump house, and is connected to the dock mains, both at the west end and the east end of the house. At each end of the main a Venturi meter is placed with connections to Kent water recorders, which are accommodated in a convenient position on the elevated platform, so that the output from the pumps is always under the observation of the shift engineer. The water recorders are fitted with drums which provide weekly charts of the output from the station. The accumulator of the self-guided type, having a ram 17in. diameter with a stroke of 20ft, is placed outside the pump house at the west wall and is connected to the hydraulic main. Tappets are fitted to the accumulator, which actuate a number of tappet switches connected to the contactor starters of the various pump motors. The starters are interlocked, so that when a smaller pump is running and, owing to a demand for motor power, it becomes necessary to start up a larger pump, the smaller pump is automatically stopped as soon as the larger pump is on load. The connections are shown in Fig. 4.

If one of the 800-gallon turbine pumps is started up the 600-gallon turbine pump is stopped and a 300-gallon reciprocating pump is started up, but if it is necessary to have more water, then the second 800-gallon pump can be started up by hand. Based



SEQUENCE POSITION OF SELECTOR SWITCHES

A	B	C	D
Tappet 1. — 1 In.	Tappet 1. — 2 In.	Tappet 1. — 1 In.	Tappet 1. — 2 In.
Tappet 2. — 4 In. 1 Out.	Tappet 2. — 4 In. 1 Out.	Tappet 2. — 3 In. 1 Out.	Tappet 2. — 3 In. 2 Out.
Tappet 3. — 5 In. 4 Out.	Tappet 3. — 5 In. 4 Out.	Tappet 3. — 5 In. 3 Out.	Tappet 3. — 5 In. 3 Out.
Tappet 4. — 5 In. 2 In.	Tappet 4. — 5 In. 1 In.	Tappet 4. — 5 In. 2 In.	Tappet 4. — 5 In. 1 In.
Hand. — 3.	Hand. — 3.	Hand. — 4.	Hand. — 4.

"THE ENGINEER"

FIG. 4—DIAGRAM OF ELECTRIC CONTROLS

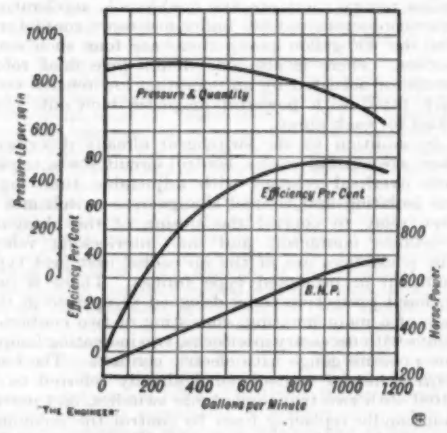


FIG. 5—CENTRIFUGAL PUMP CHARACTERISTICS

on this, the sequence of operation of the pump from the tappet switches on the accumulator will be :—

Phases.				
1st.	2nd.	3rd.	4th.	5th.
1 starts	3 shuts down 1	5 shuts down 3	2 starts	4 by hand
2 starts	3 shuts down 2	5 shuts down 3	1 starts	4 by hand
1 starts	4 shuts down 1	5 shuts down 4	2 starts	3 by hand
2 starts	4 shuts down 2	5 shuts down 4	1 starts	3 by hand

Up to phase four the total quantity delivered is

1100 gallons per minute at 800 lb. per square inch. If phase five is employed, however, the total quantity in the first two examples is 1900 gallons per minute against 800 lb. per square inch, and in the last two examples the total quantity is 1700 gallons per minute against 800 lb. per square inch. With this arrangement it is also possible to keep the two reciprocating pumps 1 and 2 running during slack periods and at week-ends.

In addition to the switches already referred to, there is one placed at the bottom which causes all the pumps to stop in case there should be a failure of the hydraulic main when the accumulator comes to the bottom of its stroke. At the top of the accumulator's stroke the last tappet switch causes all the pumps to stop.

Electric Control Gear.

The electric supply is three-phase, 50-cycle, alternating current at 6600 volts, and is brought into the station on the north side by two high-tension cables from two separate ring mains on the Leith city supply. At the north-east corner of the station an E.H.T. switchboard—see Figs. 2 and 3—consisting of a series of Reyrolle switches, is placed where the cables are connected to two main feeder switches, which, in turn, are connected to bus-bars passing through the instrument panel and main switches. From these main switches connections are made to the starters of the three centrifugal hydraulic pumps and to the three transformers. It will be seen from the arrangement that all the high-tension cables are confined to the north-east corner of the control platform.

On the south side of the control platform is placed the low-tension switchboard controlling the 400-volt supply. On this side there are placed the rotor starters for the three hydraulic centrifugal pumps and the switches for the low-tension supply.

In front of the controller platform with a clear view of the whole pump house—see Fig. 2 on page 616—there is a desk for the shift engineer, and on each side of his position are the main control panels for the two reciprocating hydraulic pumps. On his left-hand side there are three starters for the three centrifugal feed pumps; on his right-hand side are the two Kent water recorders connected to the Venturi meters; while behind him is placed the master control panel. A small panel controlling the lighting circuits in the station is placed on the east wall.

The three E.H.T. stator panels for the three hydraulic centrifugal pumps are placed in three separate compartments formed of expanded metal, each with a door fitted with an electric switch, which makes the panel dead and trips the main E.H.T. switch when the door is unlocked. The stator switches each consist of a triple-pole electrically-operated, high-tension, air-break contactor, fitted with renewable contacts and a special horn gap with a powerful magnetic blow-out. These switches are fitted with low-tension operating coils and arc shields are provided. The blow-out system on each pole comprises two coils mounted direct on each side of the gap between the fixed and moving contacts to concentrate the magnet field in this gap. All the moving contacts are clamped to an insulated shaft, which is operated by a low-tension contactor magnet. There is also a triple-pole contactor to short circuit the buffer resistance. The contactor, which is insulated for 6600 volts, has low-tension operating coils, and is mounted, together with the buffer resistance, which is placed on the opposite side. The rotor contactors are placed in a casing supported by an angle iron framework and mounted direct on the floor. For the two 800-gallon pumps there are five double-pole accelerating rotor contactors and five buffer resistance contactors. For the 600-gallon pump there are four such contactors. There is also one double-pole final rotor contactor actuated by an operating low-tension coil, each fitted with powerful magnetic blow-out, provided for each pump.

In addition to the switchgear already described, there are current relays, control circuit fuses, triple-pole overload releases with adjustable time lags, one isolating and control change-over switch and a time relay to control the closing of the charging resistance contactor, and one interlocking relay. The resistances are of the air-cooled cast grid type built up in protected type frames. There is one enclosed protective panel designed to operate in the case of a main bursting, consisting of two contactor relays with necessary interlocks, two indicating lamps, one pressure gauge with electric contacts. The low-tension master control panel already referred to is fitted with two triple-pole knife switches, and porcelain handle replacing fuses to control the incoming circuits from the transformers. There is a triple-pole change-over switch, with fuses to control the change-over circuit and feeder circuit; also double-pole knife switches to control the single phase low-tension feeder panels, with change-over switches in connection with the various controllers, so that any one of the pumps can be disconnected from the automatic working and be started and stopped by hand; also a series of plug switches, so that the feed pumps can be actuated from any one of the two floats, and their sequence can be altered at will. There are also pull-out fuses, so that any one of the pumps can be isolated.

The electric control gear was supplied by the Electric Control Company, Ltd., of Brighton, as sub-contractors to the Pulsometer Engineering Company, Ltd., which latter firm did the erection and connecting up. The transformers, like the motors, were supplied by Bruce Peebles and Co., Ltd., of Edinburgh, and are of 500-kVA capacity. The primary winding is arranged for 6600 volts, 50 cycles, and the secondary winding arranged to give 400 volts between the phases at no-load. Tappings are provided on the primary windings at plus and minus 2½ and 5 per cent. in order to deal with variations in the supply pressure. Each transformer is contained in a sheet steel tank mounted on rollers, and is fitted with an earthing terminal. The cables were supplied by Johnson and Phillips, Ltd., of London, and Mitchell Graham and Son, Ltd., of Edinburgh, were the contractors for the wiring.

The building of the power house, which is of brick and concrete construction, with the concrete foundations for the pumps on timber piling, was carried out departmentally by the dock engineers, the whole of the workmen being recruited from local unemployed men under an arrangement made with the Unemployment Grants Committee.

The Empire Broadcasting Station.

On Monday last we paid a visit to the new Empire transmitting station at Daventry, where two short-wave transmitters and associated equipment have been installed to provide a broadcasting service for British listeners throughout the Empire. Normally, the programmes will emanate each day from this country at convenient times for oversea listeners, who will be able to receive them direct, although they may also frequently be re-broadcast by existing overseas broadcasting organisations. The definite link which the scheme will provide with the Home Country should be greatly appreciated in the Colonies and by isolated British people throughout the world, who will have an opportunity of listening to news bulletins and home programmes. Although at the outset the Empire programmes will consist largely of excerpts from programmes which are being broadcast in the British Isles, owing to the times of transmission, some of the zones will have to be provided with a considerable amount of exclusive material.

CONTROL ROOM—EMPIRE BROADCASTING STATION

The building which houses the transmitters consists of a central block containing the transmitting hall shown in the accompanying illustration, control rooms and offices, whilst two wings to the building provide accommodation for the motor generators, switchgear, sub-station equipment, the valve water-cooling plant, and boiler-house, &c. All the equipment of the station is of British manufacture, and is, of course, designed on the most modern lines. The two transmitters and aerial arrays were constructed and installed to the requirements of the B.B.C. by Standard Telephones and Cables, Ltd., whilst the building was constructed by Higgs and Hill, Ltd. The control room, in which the incoming lines to the station terminate, contains the low-frequency amplifiers, which raise the programmes to suitable level for feeding the transmitters, together with the switching apparatus for the distribution of programmes to the two separate transmitters. The control and checking or "monitoring" of the programme is done in this room, and a second or subsidiary control room is provided for checking the input to the second transmitter. Both of these acoustically treated rooms contain loud speakers, but headphones are provided for use when necessary. The two transmitters are placed at opposite sides of the transmitting hall, whilst the main switchboard is at the far end and the control discs in the centre of the hall, as shown in the accompanying illustration.

As the wave length suitable for, say, Canada may be quite unsuitable for India, a number of wave lengths will be used for different parts of the Empire, and each transmitter is therefore designed for operation between 14 m. and 50 m., and so that the wave length may be rapidly changed. To provide for time variation, the Empire has been divided into five zones—Australasia, India, Africa, West Africa, and Canada—and in the eastern and western extremities of each zone reception will be at an earlier or later hour, according to the variation in the local time within a zone. The zone system enables directional aerials to be used, so that transmissions may be concentrated into a comparatively broad beam, embracing each zone, but in addition to the five different groups of directional aerials, corresponding to the five transmission zones, there are six omni-directional aerials which will be used when it is desired to give the people in all parts of the Empire an equal chance of listening to something of outstanding importance.

Each of the two transmitters is contained in four separate cubicles, and to obtain the necessary high degree of frequency stability, each master oscillator valve is controlled by a quartz crystal, a separate crystal, naturally, being employed for each wave length. In this connection doubling stages are used, and on wave lengths below 17 m., the crystal frequency is doubled three times, it being impossible to grind crystals to a size that will allow them to oscillate at very high frequencies. The output of the oscillator unit is connected to the input of the first transmitter unit which contains the frequency-doubling stages, the modulating stage, and the first modulated amplifier. The system of low power modulation, which is claimed to have several advantages over the old system of high power modulation, is employed, and the transmitter is adjusted to give the maximum possible efficiency consistent with a satisfactory linearity of response. Amplication is carried out in the second and third transmitter cubicles, each of which contains a stage of push-pull, high-frequency amplification, the first amplifier employing two 2-kW water-cooled valves, and the second two 10-kW valves of the same type. In the fourth cubicle the amplifier consists of four 15-kW valves connected in push-pull, and the output circuits from this cubicle are connected to the aerial feeder. From the power stage in each transmitter the outgoing feeders are connected to an aerial-changing panel, with a special form of selector switch, which enables either of the transmitters to be connected to the different aerials.

Power from the generating station of the Northampton Electric Light and Power Company is supplied at 11,000 volts to a sub-station on the site containing a 300-kVA transformer. High-tension D.C. power for the first power amplifier and main power amplifier is obtained in the case of each transmitter from a six-phase thermionic rectifier, having a D.C. output of 6 ampères at 10,000 volts, the output of each rectifier being controlled by a motor-operated induction regulator, which varies the associated transformer voltage. All other power supplies are provided by motor generators, which are installed in a separate room.

Water Power in Great Britain.*

By Sir ALEXANDER GIBB.

In November, 1921, there appeared the final report of the Water Power Resources Committee, which, perhaps, too highly rated the electro-chemical market using cheap power continuously and put too low a value on the domestic and ordinary industrial load requiring a varying supply, but able to pay a higher price for it. Moreover, at that time it was believed that we were under serious risk of exhausting our coal supplies, so that any means of conserving them was considered economically sound. Now we know rather more truly how these matters stand.

* Extracts from the presidential address to the Junior Institution of Engineers. In consequence of the retardation of his recovery from an accident, which occurred some months ago, Sir Alexander Gibb's medical advisers forbade his attendance at the meeting, and his address was, therefore, read by one of his partners, Mr. Hugh Beaver, Assoc. Inst. C.E. Sir Alexander's formal induction as President of the Institution will take place at a later date.

Greatly valuable as are our water power resources, their development can only be described as an important, though not a really vital, element in our country's industrial prosperity. Nevertheless, in spite of inevitable limitations, the Committee's careful investigation was a most valuable work, but its estimates are now found to have been too conservative, and the estimate of a potential total capacity of 250,000 kW continuous power then remaining to be developed from water in Great Britain could probably be doubled.

When the report was written, about 50,000 kW were actually developed or in process of development. Since then plant to the amount of over 200,000 kW has either been installed or is under construction. Further definite projects have been worked out, and in favourable circumstances could be brought to early fruition for water power plant to the total of some 250,000 kW. So that one may say that the total of definitely proved water power schemes in Great Britain is already not far from the maximum capacity envisaged by the Water Power Resources Committee, and that by a long measure does not exhaust the possibilities.

Let us consider for a moment or two what has been done before we turn to examine the factors that will govern future developments. If you take a rainfall map of Great Britain you will find seven areas of heavy, or comparatively heavy, rainfall—that is to say, with an average of 50in. or over per annum, rising in spots to over 150in. per annum. These areas run down the western side of England and Scotland, the wettest portions following very closely the configuration of the high land.

The North-West Scotland area extends to about 4000 square miles, and is, perhaps, the wettest part of the British Isles, large areas having an annual rainfall of over 100in., and a considerable part well exceeding 150in. It provides some valuable water power sites and in recent years two separate schemes came before Parliament for the development of continuous outputs of 52,000 kW and 60,000 kW respectively. Both schemes were rejected by Parliament after long drawn-out and very expensive inquiries, but not on engineering grounds.

The Central Scotland area contains approximately 4500 square miles, with an average annual rainfall also ranging up to more than 150in. It already has four hydro-electric developments, viz.: Foyers, Kinlochleven, Lochaber, Grampian. These schemes involve at present a combined installed plant of about 110,000 kW, and an ultimate capacity of over 200,000 kW. The first three schemes were developed for electro-metallurgical purposes, and, as a whole, the three comprise the largest combined water power scheme in this country.

The South Scotland area covers a fairly wet portion of Southern Scotland with an annual rainfall up to 90in. and, possibly, in a few spots, up to 100in., where the Galloway water power scheme, now under construction, will eventually comprise five power stations with a total installed capacity of 102,000 kW.

The English Lakes and Pennine area is the third area of extreme rainfall in these islands, reaching to an annual amount of about 150in. The sites that could be developed would, together, only amount to perhaps some 10,000 kW on a continuous basis. In North Wales there is a large area with an average annual rainfall in the region of 100in., but it has already been well utilised for power and for public water supply purposes. South Wales has also a large area with a rainfall average of 60–100in. It has no water power developments yet. The South-west England area is small and the annual rainfall is comparatively insignificant from the water power point of view. Developments up to about 5000 kW in all could be carried out, but would be expensive and may practically be disregarded..

The Falls of Clyde development, where 15,500 kW of plant are installed in two power stations, is of special interest, because no attempt is made to store any water, *i.e.*, the output of electricity depends entirely on the flow of the river. This involves widely varying outputs at varying seasons and hours. This scheme is only sound and commercially practicable because it forms a part of a large power undertaking where the capacity of the steam plant is greatly in excess of the water power plant, and where a suitable margin of plant capacity is provided in the steam stations to compensate, when required, for any non-availability of the water power due to drop in the river flow. The development per kilowatt of plant capacity had, therefore, to be low in first cost to justify holding in reserve the requisite extra margin of steam plant. The output of the Falls of Clyde scheme is not designed to vary in any completely controllable way with the variations of the load curve requirements of the main power system to which it is coupled.

In contra-distinction the Galloway scheme is solely a peak load station, with sufficient storage to permit the daily output being controlled so as to fit in exactly with the requirements of the winter peak demand. It will operate for approximately six hours in the twenty-four and mainly in the winter months. The load factor is only about 20 per cent., but the power for peak purposes can be produced at a lower cost than if steam plant had been installed for the peak load.

It so happens that the Galloway area lay near the proposed connecting link between the North of England "grid" and the West of Scotland. But it was an area of sparse population and in itself offered little justification for the early completion of the link. The possibility, however, by slight deviation, of picking up the 100,000 kW of plant for peak loads and emergencies justified both the carrying of the "grid" from Carlisle to Glasgow, and the water power development itself.

Our potential sites for hydro-electric development are, for the most part, in the more isolated parts of the country, distant from industrial areas and from the chief centres of consumption, and at present the length of transmission necessary, though small compared with the great distances involved in other countries, may, nevertheless, add some 25 per cent. to the cost of the power delivered and might detract very much from the advantages of a scheme.

Further, the peculiar conditions of our country rather tend to restrict full advantage being taken of even such sites as do exist. There are many factors that have to be borne in mind in considering any water power scheme, apart from the fundamental questions of market and finance. In the first place, this is a land of great density of population. Vested interests have become so strong and so numerous that one has to step very warily when one sets out to interfere in any way with the existing order of things, particularly in such a matter as interference with the flow of rivers, or their diversion from one watershed to another.

In every water power scheme in Great Britain there is so much compensation to be paid, not only on account of the flooding of land, which is natural and proper, but in respect of interference with innumerable old-standing rights, for the preservation of amenities, reinstatement of ancient privileges and conveniences, and the like, all of which are found to bear a very high cash value when they are threatened, that the burden becomes inordinately heavy. In the case of the Galloway water power scheme, now in course of construction, the capital cost of the purchase of land and fishings, compensation for various riparian, agricultural, fishing, sporting and other rights, provision of salmon passes and compensation water to the various streams affected, concessions for the improvement and safeguarding of scenic and such amenities is equal to nearly one-quarter of the capital cost of all the civil engineering works.

I am not complaining that such expenditure has to be met, that Scenery Committees should be appointed and that Commissioners for Ancient Monuments have to be appeased. We have not yet descended to handing over our heritage to uncontrolled commercial exploitation, and with what difficulty we still manage to preserve the beauties of the country is apparent to anyone who travels our roads.

There is another consideration, the influence of which is sometimes overlooked, and that is that the first call on our water supplies is necessarily for the supply of water to our immense population. The larger part of the population lives in the "dry" areas, and the total domestic and industrial requirements of pure water are considerable and pressing. Certain areas of potential water power—such, for instance, as the Lake District—must for this reason remain largely unavailable for power development.

There is, again, a serious handicap to enterprise in the heavy preliminary expenses and risks that are inevitable in our system of initiating important public works. The development of a hydro-electric scheme requires not only the concurrence, approval and assistance of the Electricity Supply Commissioners and the Central Electricity Board, and of all sorts of local authorities and Government Departments, but it requires also the sanction of the Legislature to a Bill that has to pass through both Houses of Parliament. Again, there is the price that has to be paid for all the precautions, not only to secure safety, but even to allay possible anxiety, that have to be taken whenever a public utility is established in this country. What I would emphasise is that every regulation of the Board of Trade, the Ministry of Health, the Home Office, and all the other Departments, has to be paid for in capital or operating expenditure, and increases for all time the cost of production, whether the product be manufactured goods, transport, power, or any other service. In a recent case of which I have cognisance, this consideration for the anxieties quite as much as for the actual safety of the public, determined the design of a large dam in this country, and the decision added nearly 50 per cent. to the cost.

Whenever a hydro-electric scheme is mooted there often arises a clamour on the part of local interests against what is called the "export of power." It has, for instance, been demanded that power generated in the Highlands should only be used locally, and should in no circumstances be put on to the "grid" for distribution to the Scottish industrial areas, or, even worse, to manufacturers south of the Tweed. Those who develop power from the waters on the Highland rivers and lochs are supposed to be getting something for nothing. The cost of the post-war developments shows how far this is from being the case, but the belief dies hard and this is still the underlying motive that has in the past been solely responsible for decisions disastrously adverse to water power schemes.

I sympathise with the dreams of those who, living in the sparsely inhabited areas of the North of Scotland, imagine busy trades and populous townships springing up along their coasts and in their glens, and bringing back a prosperity which, in fact, has never existed. But, with one or two exceptions, the idea is wholly visionary. The extension of the "grid" and incorporation in it of the various water power developments would, on the other hand, assist to some extent in securing a measure of industrial development there. It is essential, then, that the so-called "export of power" should be accepted as not inimical to local interests.

Secondly, a change of view is required on the part of the coal interests. It is now emphatically and insistently argued by the coal interests that the development of water power in this country is wholly uneconomic and unjustifiable, since the corresponding diminished use of coal causes a loss to the country far outweighing any immediate advantage there may be in the cheaper cost of water power, but our total potential water power would only represent about fifteen hours output of coal a year.

Thirdly, there is the matter of local rates—a most inequitable handicap on hydro-electric development in this country—that must be remedied. Without going deeply into this involved question, I may explain very briefly that the rating of power stations is based on a theoretical rental value calculated primarily on the capital cost. In the case of a steam power station, the annual cost of fuel is allowed as an offset. With a water power station there is no such offset, and the result is that the difference between two stations of equivalent power is about 1 : 3 in favour of the steam power station.

Fourthly, I hope that it may not be impossible to devise a less costly and less hazardous method of obtaining the necessary powers than by means of a Private Bill passing through Committees of the two Houses of Parliament, where it may stand or fall on the chance whether a single disgruntled Member of either House desires to oppose.

Finally, I suggest that for the development of water power in this country to its full economic capacity it is necessary that the Central Electricity Board should not only co-operate as it does now to a most valuable degree, in the financing and carrying out of an approved scheme once Parliamentary sanction has been obtained, but should also take a more active—in fact, the principal—part in the preliminary stages.

Water power, once developed, is a permanent asset for all time of increasing value. Moreover, the present is a peculiarly suitable time. For the first time we are once more approaching pre-war costs of construction. Unskilled labour remains nearly double the pre-war cost—some materials, such as cement, are still much higher, but improved methods and the present intense competition very largely offset these. In a large dam contract recently awarded, the prices are only 10 per cent. above the pre-war level; in an important tunnel contract not more than about 20 to 25 per cent. The position is even more favourable when the price of money is considered, since the cost of the capital governs the cost of power in hydro-electric schemes to the extent of about 80 per cent. The present is, therefore, a particularly favourable time for the cheapest exploitation of our water power resources.

At the same time the required markets may be materialising. I notice that 7 per cent. of the total output of electricity in France—which is some 10 per cent. to 15 per cent. in excess of our own figure—is consumed by ferro-alloy and calcium carbide manufacturers. Here, apart from aluminium, its use for electro-chemical or electro-metallurgical purposes is almost negligible. There must, I think, be a big extension in such uses and manufactures in this country, and I should not be surprised if the new development is going to be greatly assisted by the new tariffs.

The Arkwright Bi-centenary.

THE bi-centenary of the birth of Sir Richard Arkwright, the great master cotton spinner of the eighteenth century, occurs a week to-day. To mark the occasion a public lecture was delivered by Mr. Frank Nasmith, F.T.I., on Wednesday last at the Science Museum, South Kensington, under the auspices of the Newcomen Society for the Study of Engineering and Technology.

The lecturer's conclusions generally were that, however important Arkwright's inventions were, his great claims to our remembrance at the present day were his two great achievements, viz.:—The combination in ordered and due sequence of machinery of his own and others' invention for accomplishing every process required between the bale of raw cotton and the finished yarn; and his organising ability shown by the adoption of the factory system which replaced the former domestic industry.

Arkwright came into the world when the cotton industry was on the eve of fundamental changes. The year before his birth, which occurred at Preston, Lancashire, as one of a large family in poor circumstances, John Kay, of Bury, had invented the fly shuttle, which so increased the weaver's output that it caused a shortage in yarn, spun only, of course, a single thread at a time. Hence attention was directed to speedier methods of spinning. To reproduce the action of the finger and thumb in controlling the feeds of the cotton fibres to the spinning wheel, and to multiply the number of spindles working simultaneously, was the aim of the inventor. The first desideratum was achieved by the master invention of drawing by rollers, *i.e.*, feeding a roving of cotton between two or more sets of rollers in series, each set rotating at a greater speed than the one anterior to it. Lewis Paul must be credited with the invention—see his patent of 1738—of spinning by rollers and with having made some progress in developing the invention, but without finally bringing it to a practical success. James Hargreaves, of Blackburn, pursued a different principle—that of attenuating the roving by a to-and-fro motion of a travelling carriage. He was occupied with this invention, it is believed, from 1764 to 1767, and patented it in 1770. The machine was known as the "Spinning Jenny," and was the forerunner of Crompton's "mule," so named before it embodied both principles.

Arkwright, who was apprenticed to the trade of a barber and had a shop in Bolton, was fully aware from the talk he heard continually around him of the urgent need of the industry. He was inquisitive, had an acute mind and self confidence. About 1767 he gave up barbering to take up cotton spinning. In 1769—the same year, by the way, that Watt patented the separate condenser steam engine—Arkwright patented a spinning frame in which he embodies four sets of rollers in series. The rollers were in four lengths, so that four threads were thereby drawn. Beyond being belt driven, the spindles that twisted the thread and wound it into a cop were similar to those used in the hand wheel. A few years later he improved the details, increased the number of spindles, added the heart cam for building the cop, and arranged the frame for driving by water power. Hence the popular name of "water frame." In 1775 Arkwright took out another patent to protect machines used for other stages of the process, *e.g.*, the carding engine. Whether intentionally or not, this specification is most obscurely worded.

Great as were Arkwright's constructive abilities, it is by his transformation of the cotton industry from a hand and domestic one into a machine and factory system that he will be lastingly remembered. He began business about 1768 with John Smedley at the Woolpack Mill, Nottingham, but their capital was soon exhausted, and it was his celebrated partnership of 1769, and life-long friendship with Jedediah Strutt, of Belper, a man of high character and sound business sense, that gave Arkwright his real opportunity. The building of the famous mill at Cromford, Derbyshire, filled with new machines for every stage in the process, followed in 1771. It may be well to remark that the aggregation of workers in factories to carry on industry in association was not new at this date, but Arkwright was the first to adopt it in the case of cotton and to apply motive power in a more systematic and complete manner than had been done previously.

The industry was so profitable that competitors quickly embarked upon it, and when, in 1781, Arkwright successfully sued a number of them for infringement of his patent, they became alarmed. The outcome, after much embittered controversy, was the famous trial of 1785, the result of which was that the patent of 1775 was annulled on the ground of insufficiency of description. It may be remarked that the validity of Arkwright's patent of 1769 was never attacked. The annulment, however, hardly disturbed the flood tide of his success, and at the time of his death on August 3rd, 1792, at the comparatively early age of sixty, he was worth half a million of money.

Modern Hydraulic Operation of Machine Tools.*

By H. C. TOWN, A.M.I. Mech. E.

(Concluded from page 588.)

Conclusions.—A survey of machine tool development shows that hydraulic operation has been applied to all types with the exception of slotting machines and boring and turning mills. Surface grinding machines with rotary tables may be included as a sub-division of grinding

traversing saddle, which necessitates flexible tubing if the pump and control units are mounted on the column or base; if mounted on the saddle the complication of these parts with extra space and weight tends to make the saddle out of all reasonable proportion for efficient operation.

Slotting machines would appear to be waiting for a lead, for while, as stated, reciprocating machine tools are amongst the least suitable for hydraulic transmission, there is little difference in the operation of slotting and shaping machines to which application has already been made.

Boring and turning mills are in a different category

menting gravity feed by applied regulated pressure, giving relief on the return stroke with an automatic lift of the saw frame to the top position on completion of the operation.

It may be stated, then, that for practically all machine tools the difficulties of securing accurate control for feed and speed variation have been surmounted, and the complications of screws, racks, gears, and clutches, &c., with the attendant possibility of the flexing of the members at many points in the transmission, has been eliminated. Fluid pressure has long been considered as desirable, and the recent close co-operation between the hydraulic engineer and the machine tool designer has not only accom-

TABLE I.—*Grinding Machines.*

Type and capacity.	Hydraulic equipment.	Final table transmission. Spindle or tool traverse.	Pressure, lb. per sq. in.	Make.	Additional features.
Cylindrical: 10in. dia. × 60in. long	Rotary vane pumps	Piston and cylinder, under table	Max. 150	John Lund, Keighley	Hydraulic work drive; hydraulic in-feed; tailstock
„ 6in. × 30in. to 20in. × 72in. long	„ „ to hydraulic motor	Rack and pinion *vid* hydraulic motor	Aver. 70	Landis Tool Company, U.S.A.	„ in-feed by hydraulic motor
„ Roll grinder	Variable-delivery pump to hydraulic motor	Do. do. do.	Max. 600	Churchill, Manchester	Output of pump, 3 H.P.
„ Crank-pin and crank-shaft	Gear pump	Piston and cylinder, under table	„ 250	Do. do.	Hydraulic in-feed by piston and cylinder
„ Range of sizes	Rotary vane pump to hydraulic motor	Rack and pinion *vid* hydraulic motor in apron	„ 140	Mayer and Schmidt, Germany	Hydraulic work drive, by Enor motor
Internal: 23in. dia. × 21in. long	Enor rotary vane pump	Piston and cylinder, under table	„ 150	Wotan-Werke, Germany	Do. do. do.
„ 4in. to 5½in. bore × 8½in. long	Gear pump	Do. do. do.	„ 250	Heald Machine Company, U.S.A.	
„	Enor rotary vane pump	Do. do. do.	„ 150	Fortuna-Werke, Germany	Hydraulic work drive, by Enor motor
Screw-thread grinder	Gear pump	Reverse bevel gear. Oil-controlled	„ 70	Société Genevoise, Switzerland	
Surface: Vertical 24in. dia. wheel	Constant-delivery rotary pump	Piston and cylinder on extension end of bed	„ 250	Lumsden, Gateshead	Cylinder on side of machine for saddle traverse
„ Horizontal tool-room type	Gear pump to hydraulic motor	Rack and pinion	„ 200	Samsonwerke, Berlin	
„ 3-way open side, 6ft. long × 5ft. high	Gear pump, 3 H.P.	Piston and cylinder, under table	„ 250	John Lund, Keighley	Hydraulic in-feed to column and vertical feed to saddle on ditto
„ Horizontal	Do.	Do. do. do.	—	Diskus-Werke, Germany	
„ Plano type	Do.	Do. do. do.	„ 250	Snow, Sheffield	
„ „ 5ft. to 10ft. long × 2ft. 3in. wide	Do.	Piston and cylinder on extension at end of bed	„ 250	Churchill, Manchester	
„ „ up to 20ft. long × 9ft. high	Do.	Piston and cylinder under table	„ 250	John Lund, Keighley	Two Cylinders on large machine; hydraulic saddle traverse

TABLE II.—*Honing Machines.*

Vertical, 16in. stroke	Variable-delivery pump	Piston and cylinder, top of spindle	Max. 1000	Barnes, U.S.A.	Gear drive to spindle rotation; hydraulic reciprocation
„ 32in. stroke	Do. do.	Duplex do., each side of spindle to save height	„ 1000	Do.	Do. do. do.
„	Do. to hydraulic motor	Piston and cylinder, top of spindle	„ 1000	Meyer and Schmidt, Germany	Rotary and reciprocating motions actuated hydraulically

TABLE III.—*Broaching Machines.*

Horizontal, 56in. to 54in. stroke	Variable-delivery pump	Piston and cylinder, centre of slides	Max. 1000	J. N. Lapointe, U.S.A.	Pulling capacity, 31,400 lb. to 73,000 lb.
„ „ „ „	Do., and booster gear pump	Do. do. do.	„ 1000	Oilgear Company, U.S.A.	„ „ 25,700 lb. to 45,000 lb.
Vertical	Variable-delivery pump	Duplex do., adjacent to slides	„ 1000	American Broach and Tool Company	„ „ 12 to 50 tons

TABLE IV.—*Planing, Shaping, and Slotting Machines.*

Planing, 27ft. stroke	Variable-delivery pump	2 cylinders and pistons; cutting; 1 for return	Max. 1000	Billeter and Klunz, Germany	Cutting, 76ft. per min.; return, 200ft. per min.; piston-rods 31ft. long on telescopic rests every 3ft.
„ 13ft. × 6ft.	Do. do.	Traversing cylinder block; moving and fixed rods	„ 1200	A. Waldrich, Germany	Cutting, 262ft. per min.; return, 262ft. per min.; hydraulic feed to saddles
„ small tool-room type	Do., rotary vane type	Piston and cylinder, under table	„ 170	Paul Blell, Zoulenroda	Cutting, 80ft. per min.; return, 143ft. per min.; max. pressure, 4700 lb. per sq. in.; hydraulic feed
„ open side, 4ft. 6in. to 8ft. 6in. stroke	Variable-delivery pump	Do. do. do.	„ 1000	Rockford Tool Company, U.S.A.	Cutting, 65ft. per min.; return, 225ft. per min.; max. pressure, 5 tons; hydraulic feed
Shaping, 18in. stroke	Do. do.	Piston and cylinder, centre of ram slide	„ 1000	American Broach and Machine Company	Cutting, 60ft. per min. on 6in. stroke; 20ft. on 18in.; max. pressure, 3½ tons
„ 10in. to 34in. stroke	Hydraulic motor	Hydraulic motor to link motion	„ 900	Lance and Geilen, Germany	Cutting, 160ft. per min. max.; return constant, 200ft. per min.; max. pressure, 2·2 tons

TABLE V.—*Milling Machines.*

Plain millers, range of sizes	Variable-delivery pump, low-pressure gear pump, high-pressure booster	Piston and cylinder, under table	Max. 1000	Cincinnati Milling Machine Company	
„ „ „	Variable-delivery pump	Do. do. do.	„ 1000	Sundstrand Machine Tool Company, U.S.A.	Hydraulic work, clamping and indexing
„ „ „	Do. do.	Do. do. do.	„ 1000	Cuttat, France	
Vertical millers, range of sizes	Do., Lauf-Thoma, pump and motor	Hydraulic drive to spindle	„ 1000	Wanderer-Werke, Germany	Mechanical feed

TABLE VI.—*Lathes.*

Multi-tool, 6in. dia. × 12in. long	Gear pump	Sliding: piston and cylinder; facing: piston-rod *vid* rocking lever	Max. 250	Drummond, Guildford	Hydraulic loose head, spindle, belt shifting, chuck
„ automatic	Do.	Sliding: do., facing; rack and pin *vid* cylinder and piston	„ 250	Cuttat, France	Both cylinders front of bed, hydraulic chuck
„ „	Do. (duplex)	Sliding: do., facing; guide bar *vid* cycle and piston	„ 250	John S. Barnes, U.S.A.	1 cylinder bed centre, 1 front of bed vertical, 1 pump feed, 1 rapid traverse
„	Do.	Sliding: do., facing; 2 small cylinders and pistons	„ 250	Sundstrand Machine Tool Company, U.S.A.	1 cylinder bed front, 2 on long slide
Crank shaft lathe	Variable-delivery pump	Toggle mechanism *vid* hydraulic cylinder	„ 1000	R. K. Le Blonde, U.S.A.	
7in. centre sliding lathe	Do. do.	Piston and cylinder, front of bed	„ 600	Dean, Smith and Grace, Keighley	Hele-Shaw Beacham pump

TABLE VII.—*Drilling and Boring Machines.*

3-head multi-spindle horizontal drill	Variable-delivery pump	Piston and cylinder, adjacent to slide	Max. 750	Asquith, Halifax	
Multi-spindle, horizontal drill	Do. do.	Do. do. do.	„ 1000	National Auto Tool Company, U.S.A.	Hydraulic and pneumatic control, unit heads
„ vertical	Do. do.	Do. do. do.	„ 1000	Foote-Burt, U.S.A.	Feed 1in. to 13in. per min., rapid traverse 175–250in. per min.
„ „	Variable-delivery, 2 gear pumps	Do. do. do.	„ 1000	J. Archdale, Birmingham	

machines, and radial drilling machines likewise in their own class.

In this last case attempts have been made to incorporate hydraulic transmission, but without sufficient success or advantage over geared feed to warrant placing the machine on the market. The difficulty arises with the

altogether; a powerful rotary drive is now required, and may eventually be forthcoming in the form of hydraulic motors similar to the ones described. The same remarks apply to the rotary table surface grinder, which to compete efficiently with reciprocating grinders is greatly in need of hydraulic operation.

Hydraulic operation of auxiliary machines such as hack-sawing machines is well established, in this case supplie-

plished this, but has done so with a simplification of design at a time when levers and controls for rapid and other traverses were accumulating to an alarming extent. The information required varies with different machines, but may be briefly stated to be: power required to move saddle along slides for feed and rapid traverse; speed of traverse, maximum and minimum rates; length of stroke, maximum and minimum; cycle of operation, and whether

* The Institution of Mechanical Engineers.—Abstract.

auxiliary functions are required. For hydraulic drives the maximum and minimum speed and horse-power are required.

Hydraulic transmission should not be applied in cases where an accurate relation must be maintained between two co-ordinated motions. All components in the equipment should be fitted as accurately as possible to avoid leakage, and because of the ability of the oil to absorb air or gases caused by overheating of the transmission fluid, measures must be taken to exclude entrance or facilitate escape of air and gases. These measures usually consist of air drains in a high part of the pipe line and a large oil reservoir or oil cooling radiator with a fan.

A straight mineral oil should be used and it should have a good cold or pour test to ensure that it does not become unduly sluggish in cold weather and thus impose resistance to free movement of the parts to be operated.

The viscosity will naturally be controlled to some extent by the ability to prevent leakage and loss of oil, but the lightest bodied oil that can be used without undue leakage will give the best results.

To reduce slippage loss the unit pressure as well as the quotient of the periphery and the total displacement surface of the cylinders should be kept as low as possible. The power output is given by the product of the pressure on the piston and the average piston speed; since, however, the unit pressure should be kept low and the displacement surface as large as possible, it will be seen that to obtain the maximum efficiency the piston speed or the displacement per unit of time must be increased. However, taking into consideration this fact in relation to the friction losses, the unit pressure should be maintained at a certain level in order to keep the oil delivered per unit of time at a maximum, the pump capacity being determined by the product of the unit pressure and the oil delivery per second.

Pipe line friction should not be neglected. It is important, therefore, to attempt to keep the suction line of short length and to make use of a large enough pipe to suit the conditions of length of pipe, quantity flowing, and viscosity.

It is extremely important that the cylinder bore should be accurate, and heavy phosphor-bronze tubing is generally used. Cast iron pipe cylinders bored and jointed in lengths are quite satisfactory; or for short traverse, the bed or other casting on the machine can often be utilised for the cylinder without difficulty. Until recently seamless steel tubing was rarely accurate enough, but it can now be obtained bored and honed, so that leakage between piston and cylinder under a pressure of 1000 lb. per square inch can be kept within 4 cubic inches per minute, depending on cylinder diameter, which may range from 1¼in. to 7in. and up to 15ft. long. Correct size for diameter, parallelism, and circularity is maintained within 0·0005in.

It would appear that the chief competition with hydraulic transmission will come from electrical developments, especially for reciprocating tools of the planing machine class, so that it may be that the machine tool of the future will comprise the best features of both systems. There will also be a good field left for geared drives in cases where a wide speed range is not required, and this will not be seriously altered until the hydraulic motor can compete on a price basis. Moreover, the unit systems of machine construction is extending, wherein by means of small electric motors the source of power is brought as near as possible to the machine spindle or traversing part and the final connection is by means of two pick-off gears.

Nevertheless, it is true to say that hydraulic transmission has developed more rapidly than any other feature in machine tool design and has come to stay. The limitations and disadvantages when compared with any other form of transmission are extremely few, and even these will be reduced in the near future. Tables I.–VII. give some indication of the trend of development of each type of machine tool.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Seasonal Disturbances.

THE approximation of Christmas and the end of the year has brought about the usual derangement of business. In Midland and Staffordshire industrial circles efforts are being made to clear the works as far as possible before the holiday break. Not only is an endeavour being made to get work completed, but manufacturers are anxious to clear their yards of stocks of material so as to facilitate stocktaking. Naturally under these circumstances there has been a slackening of activity in the iron and steel market this week. Iron and steelmasters, however, are satisfied that the falling away of business is due only to seasonal influence, and recent expansion of demand in many branches serves to create a feeling of confidence in the New Year. Towards 1933 all eyes are now turned, and generally speaking prospects are held to be bright.

Pig Iron.

Midland pig iron producers are in a better position and they are encouraged by the inquiries and orders for supplies covering the first three or four months of the New Year. On this account, some good tonnages have been arranged on the present basis of prices. Indeed, it is reported that forward buying of pig iron will absorb a good proportion of the output between now and the end of March next. Blast-furnacemen have stocks on hand amounting to a considerable tonnage, and the depletion of these will depend upon how far developments involve increased consumption over the first quarter of the New Year. It is feared that it must be some considerable time before any question of relighting furnaces for the production of forge and foundry grade iron can be considered. Sales of forge grades on the Birmingham market are very few, while foundry material for the most part is being consumed by the light foundries. The very slight betterment at the heavy foundries in this area recently recorded is, however, just about maintained. Recent movements in the exchange encourage the hope that the field for British pig iron in export markets may be broadened. Selling prices of raw iron are unchanged, being on the basis of £3 6s. per ton for Derbyshire No. 3 foundry, £3 1s. for forge and £3 2s. 6d. for Northamptonshire foundry, £2 17s. 6d. for forge; standard basic iron is quoted £3 2s. 6d. delivered.

Staffordshire Bar Iron.

In the Staffordshire finished iron trade conditions similar to those ruling a week ago are in force at date. This branch of local industry is feeling the effects of the moderate trade revival least of all. For one thing in the main categories of the trade foreign competition does not enter into the picture, and the slackness at the works is entirely due to the national trade depression. In the common bar department where makers have to meet competition from Belgium, the altered circumstances are not such as to rule out purchases from abroad. Belgian No. 3 iron used by the nut and bolt and fencing industries of the Black Country is still over a pound a ton below Staffordshire material used for similar purposes. Consequently it is still coming into this district in large quantities to the detriment of local ironmasters. Producers of Crown and common bar iron find regular working impossible, and they have difficulty in disposing of their output. After marked bars, perhaps the best placed section of the iron trade is that relating to iron strip. The tube works are taking fairly good quantities week by week, and demand tends to increase. Selling prices show no change on the week. Marked bars are £12 per ton at makers' works, Crown bars £9 upwards, nut and bolt bars £8, fencing bars £7 15s., and wrought iron gas tube strip £10 7s. 6d. to £10 10s. delivered.

Steel.

The general position in the steel trade is unaltered on the week. Demand has not advanced further, neither have there been any major price movements. Business in finished material continues small, but in the semis branch it continues to expand. Competition from the Continent is only effective in a few finished products, such as joists, large plates, and sections, which are used in the constructional engineering industry. There is a somewhat easier tendency in some classes of foreign half-products, and a fall of 5s. per ton in quotations for small steel bars has given local steelmasters cause for thought. There is a slowly expanding demand for small bars, and billets from local steel works; indeed, local producers are gradually getting the upper hand. They note, however, the latest movement towards a decline in Continental quotations, and it has had a sobering effect upon those steel masters who were inclined to raise their prices on account of the improved demand. As users do not care to have any bulk of supplies in their works at the end of the year when stocktaking normally takes place at many of them, specifications are being kept down. No more material is being delivered to the works than they can absorb between now and the Christmas break.

Galvanised Sheets.

District galvanised sheet mills have not sufficient orders to keep plant running to full capacity. Orders are mostly confined to small tonnages, especially so on home account. While there is little evidence of a probable increase in home consumption, makers are able to look more hopefully towards overseas markets. Exports of galvanised sheets to India should be greatly stimulated by the preferential terms now definitely awarded to manufacturers in this country in return for similar favours. In years gone by the sheet trade with India was a very valuable one indeed, and rollers here are hoping to be able to regain a good deal of the ground lost over recent years to Belgian competitors. A 30 rupee preference or a 53 rupee preference where sheets are rolled from sheet bars brought from India is a substantial concession and one which local sheet makers hope to make much use of. Inquiries from India are reported to be in circulation already, and some substantial orders are expected to accrue. The selling price of 24 gauge corrugateds for the home trade is £11 5s. delivered in lots of 10 tons and upwards, with graduated increases for smaller lots. Export business is done at £10 per ton f.o.b. There is no change in prices of black sheets, which are quoted £9 5s. per ton upwards for the home trade and £8 5s. f.o.b. for shipment overseas.

Trade Development at Coventry.

The development officer of the City of Coventry announces that arrangements have been made with three local firms, which have made rapid progress in the manufacture of commodities, some of which were hitherto unknown in Coventry and need more extensive premises, for the lease of portions of the Meteor Works recently acquired by the Corporation. A. C. Wickman, Ltd., one of the firms concerned, manufactures Widea metal under licence from Krupps. Cornercroft, Ltd., another of the firms, makes a patent motor wheel disc and metal tire covers, and also metal spinnings for aircraft. The third firm is the Coventry Gauge and Tool Company, Ltd., which already has large manufacturing premises in the city. It specialises in all types of measuring equipment and electrical recording and control instruments. It is understood that the three firms contemplate further new developments, and all will require additional plant and will employ a larger number of workpeople.

Automobile Engineering.

An expansion of overseas and Continental demand for British automobiles is at the moment affording considerable trade assistance to the City of Coventry. Motor car manufacturing firms are, as a result, able to maintain a fairly steady output during these closing weeks of the year, when there is invariably a check to the home trade. In Birmingham and Wolverhampton also the trade position is slightly better than it was at this time last year. In the heavy section, however, quiet conditions rule. Automobile engineering programmes for the 1933 season in nearly all cases show extension sufficiently large to provide evidence of the confidence manufacturers have in the forthcoming year.

Unemployment.

The figures of unemployment recently published by the Ministry of Labour, though less unsatisfactory for this area than for most others, act as a caution against drawing general inferences from the improvement which is manifest in some departments of trade in the Midlands. It is in this area that the most consistent recovery has been made in recent months. Though November saw an increase in the number of Midland unemployed, the result was less unsatisfactory than in any other administrative division. As a distributing centre, Birmingham is now recruiting labour in various branches of activity—a useful offset against seasonal decline in others. December employment may not be unsatisfactory. Naturally the holidays will prevent any real comparison of the November and December figures.

£42,000 Sewerage Scheme.

Walsall Rural District Council has approved a joint sewerage scheme costing £42,000, in which the District Council and the Walsall Town Council will participate. The project prepared by Messrs. Willcox and Raikes, of Birmingham, is for the reconstruction and enlargement of Goscote sewage works.

Locomotives for India.

Orders for thirteen locomotives for Indian railways have, I learn, been placed during the past fortnight with W. G. Bagnall, Ltd., of Stafford. Seven of these locomotives are for the Mysore State Railways and the remaining six are intended for service on the Gaekwar of Baroda's State Railway.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The Oil-engined Motor Omnibus.

COMPARATIVE figures relating to the costs of running motor omnibuses fitted with oil engines were given by Mr. J. S. Hill, the Chairman of the Manchester Corporation Transport Committee, on the occasion of the opening of an extension to the Department's motor omnibus garage at East Didsbury, Manchester. Prefacing his remarks with the statement that the oil engine has come to the rescue of the Transport Committee, Mr. Hill said that for the week ending November 5th motor omnibuses fitted with the oil engine had travelled 33,808 miles at a fuel cost of 0·421d. a mile, or a total of 0·557d. a mile, including a cost of 0·136d. for lubricating oil. The fuel and oil cost of the oil-engined omnibuses for the week in question amounted to £78. The cost of running on petrol on a comparative basis would have been £449 for the week, the cost of petrol-running being 2·63d. a mile. The saving in favour of the oil-engined vehicle was, therefore, equivalent to £371 a week. Garage costs for motor omnibuses were discussed by Mr. T. H. Adams, Chairman of the Transport Works Committee. The cost of the extension to the East Didsbury garage was about £50,000, or, based upon the fact that accommodation was provided for 115 omnibuses, £435 per omnibus, whereas the Department's thirty-omnibus garage at Queen's-road cost £681 per omnibus.

Horwich Railway Works Rumours.

Rumours have been current during the past week that the workshops at the Horwich, near Bolton, depôt of the London, Midland and Scottish Railway Company were to be closed down and the work transferred to Crewe. These rumours, however, appear to be groundless. The position is explained in a statement made by an official of the company at Horwich. The L.M.S. have not been building locomotives at Horwich for about eighteen months. On the other hand, repair work has been carried out there to a greater extent than ever, and with the closing down recently of the company's Newton Heath (Manchester) wagon works much of the work and about 200 men have been transferred from Newton Heath to Horwich. Moreover, Horwich is now in charge of the maintenance of the company's electric coaches and special plant for this work has had to be installed. The position is summed up in the statement that Horwich is getting more work, not losing it, that the Horwich works are busier than ever, and that there is little danger of the 2500 men employed there losing their occupation.

Transporting Locomotives: Difficulties Solved.

Eight main line locomotives made by Nasmyth, Wilson and Co., Ltd., of Patricroft, near Manchester, for use on the Tientsin-Pukow line of the Chinese National Railways, left the works on Sunday morning for Manchester Docks for shipment to China. Although of normal gauge, the fully assembled locomotives and tenders, because of their size, presented a number of transport difficulties which had to be overcome by the London, Midland and Scottish Railway Company. On account of the height and breadth of the engines, it was necessary to lower the railway lines under several bridges, and, in the case of one station on the route, to slew the lines away from the platform to allow passage room. Afterwards the lines were replaced in position for the resumption of normal traffic on Monday morning.

Non-ferrous Metals.

Copper has been the centre of interest on the market for non-ferrous metals during the past week, and selling pressure has brought quotations for standard brands to about the lowest level for four or five months. The primary cause of this selling movement has been the failure of the New York conference of producing interests to reach an agreement, although the slight recovery in the sterling-dollar exchange during the past week has not

been without its influence. At the moment of writing, the metal is quoted at slightly above the worst, but, even so, the loss on balance for the week has been little short of £3 per ton. Tin also has displayed marked weakness, but in this case the decline has been relatively much less important, current quotations being rather more than £2 per ton below those ruling a week ago. The loss, however, has been sufficient to bring tin values back to where they were in the middle of October. In neither section of the market has buying interest shown any substantial improvement. The demand for lead has been quiet and a seasonal expansion of the stocks of the metal, coupled with a sympathetic reaction to the movements in other sections, has depressed prices to such an extent that those now being indicated are the lowest for over four months. Spelter has shown a fairly satisfactory resistance to the bearish tendencies, mainly in consequence of the relatively healthy statistical position, and prices are down only by a shilling or two on balance for the week.

Iron and Steel.

Buying interest in iron and steel products is at a seasonally low level, although in the case of foundry pig iron one or two of the leading makers have booked a few contracts extending over the early months of next year. For the most part, however, consumers are rigidly restricting buying operations to early requirements, and until early in January there is no prospect of more active conditions. Scrap supplies are pressing heavily on the foundry iron market, and at the moment prices of scrap seem to be tending lower, sales having been reported during the past few days at less than 30s. per ton delivered. Values of foundry iron are on the same basis as before, Derbyshire and Staffordshire brands of No. 3 being quoted at 67s. per ton, Northants at 65s. 6d., Derbyshire forge at 62s., Scottish iron at about 82s. 6d., and West Coast hematite at 81s., all delivered to works in the Manchester district. The bar iron trade is quiet, but quotations are maintained, with Lancashire best quality material at £10 5s. per ton and Crown bars at £9 15s. Reports regarding steel trade conditions in this area are not encouraging, and in no branch of the trade are orders being given out on more than a retail scale, with the paucity of business probably more pronounced in the case of constructional engineering than in any other branch. Small re-rolled bars are being quoted up to £7 per ton, but as much as 10s. below this figure has been accepted during the past week for comparatively small parcels of all-British bars. In other respects, values are steady at about £8 10s. per ton for boiler plates, £8 17s. 6d. for tank plates, £8 15s. for joists, £8 7s. 6d. for sections, and £9 7s. 6d. for large-diameter bars. Offers of Continental materials here have eased off a little in consequence of the appreciation in sterling, but new business is virtually at a standstill.

BARROW-IN-FURNESS.

Hematite.

There is a slightly better tone ruling in the hematite pig iron trade, and buyers are a little more prone to order, but they are still keeping within bounds, not greatly caring to place orders for forward delivery. The ironworks at Barrow are producing again, and during the last week there were coastwise shipments, including a parcel for Antwerp *viâ* Glasgow. The Continental trade is still quiet, and American business is lacking. There does not appear to be any sign as yet of a distinct recovery. The iron ore trade is a little better, with two more furnaces in blast, and foreign ore has been arriving. The steel trade is moderately quiet, and a few orders are held locally and are now being dealt with. The rail mills started at Barrow last week and it is hoped that they will be kept engaged for some time.

Shipbuilding.

The holidays at Vickers-Armstrongs' works this Christmas are to be very short; in fact, most of the hands will only be off for two days. The 22,000 tons ship "Bermuda Queen" is urgently needed, and this fact, to some extent, accounts for the short spell off. There is no official confirmation of the Portuguese order for two submarines, but it may be taken as a certainty that Barrow will build them.

SHEFFIELD.

(From our own Correspondent.)

State of Trade.

WHILST local industry has improved considerably of late, nothing can be gained by exaggerating the position, for the fact remains that the revival is only partial, and in many cases works are employed well below capacity. This applies particularly to the heavy branches, where work and orders continue at a comparatively low level. The revival is mainly in special and light steels, in stainless steel, for which there is a good demand, and in tools. A big trade is being done in permanent magnets and steel strip. Some English motor car firms are now using anything up to 50 per cent. more British steel than last year. For a good many years they have been using foreign special steels for constructional purposes, but owing to the tariff and the exchange this foreign material is now almost as expensive as British, which explains the increased use of the home product. The paucity of orders for shipbuilding, railway, and colliery steel is responsible for much of the present slackness, and general motor car requirements are below last year's record.

Open-hearth Steel.

When another open-hearth furnace is put into commission at Lysaght's works at Scunthorpe, the works will be on full capacity for the first time for many years. This great steel-making establishment can report substantial progress this year, the output of ingots having been from 25 to 30 per cent. more than in 1931. The output has been maintained at 75 per cent., whereas the average of the country has been only between 40 and 50 per cent. of capacity.

Railway Materials.

World-wide economy in the ordering of railway materials continues to have its effect on Sheffield and district manufacturers. India for a long time has been very sparing in her inquiries, but it is hoped as a result of the Ottawa decisions that Sheffield will receive a bigger share of the business than in recent years, when price considerations caused a lot of wheels, axles, and tires formerly bought in Sheffield, to be ordered from Continental manufacturers. Inquiries have been received through the India Store Department for 135 tons of spring steel and 182 tons of mild steel angles, plates, &c. Some Sheffield railway material manufacturers have lately been booking orders for springs and other parts of heavy road motor vehicles.

Steel Output.

Production of steel ingots and castings in the Sheffield area in October amounted to 63,800 tons, compared with 65,900 tons in September, and 75,700 tons in October of last year. The total included 20,500 tons of acid, and 38,300 tons of basic steel. The Lincolnshire output in October was 41,100 tons, an increase of 7000 tons on the month and of 5000 tons in comparison with October last year.

Another Boiler Drum Order.

Only recently the English Steel Corporation received an order for solid-forged steel boiler drums for the Fulham power station. Now comes the news that it is to manufacture at the Vickers works, Sheffield, the whole of the solid-forged boiler drums required for the three high-pressure Stirling boilers to be installed in the Southwick power station of the Brighton Corporation. There is an ever-increasing demand for steel boiler drums capable of working at higher pressures, higher temperatures, and of much larger diameters than formerly. They call for the casting of steel ingots up to 170 tons each, followed by hollow forging and machining.

Work for Russia.

Davy Brothers, the well-known Sheffield engineering firm, which has supplied the major portion of the wheel-forging and rolling plant at Taylor Brothers' Trafford Park Works, Manchester, are at present making a similar plant, in collaboration with Taylor Brothers, to the order of the Soviet Government.

Steel Sleepers.

The announcement that the Great Western Railway has placed an order for 100,000 steel sleepers to be used in its 1933 re-laying programme, is of special interest to Sheffield manufacturers who are hoping for a considerable share in the work. By the end of next year the company will have laid in its main, relief, and branch lines some 400,000 steel sleepers, equal to 185 miles of track. The new order represents about 10,500 tons of steel, in addition to which a further 46,500 tons of steel rails, fish plates, bolts, and girders for bridges and structural work will be required, making a total of 57,000 tons for next year's programme.

L.M.S. Improvements.

The L.M.S. Railway will now be enabled considerably to expedite the large volume of freight traffic passing between the Midlands and Lancashire as a result of the completion of an important scheme of bridge strengthening on the Miller's Dale and Buxton section of the through route from Derby to Stockport. Four bridges, originally built of ironwork, have been reconstructed with 320 tons of steel each, the total weight of the four new bridges amounting to 2600 tons of material. The strengthening of these bridges will now enable the heaviest types of locomotive to work through freight trains between Rowsley sidings, in Derbyshire, and Edgeley Yard, at Stockport, and will avoid the necessity for transferring such traffic intermediately at Buxton. This improvement in through freight train working will be still further assisted by the provision of new loop lines at Dove Holes and at Hazel Grove, Stockport.

Humber Bridge.

Although the Government has withdrawn the offer of assistance to the extent of 75 per cent. for the construction of the Humber Bridge, the promoters of the Bill have by no means given up hope. They are confident that the money can be raised privately for the building of the bridge if the Government will guarantee any deficiency from the tolls to be charged. The original estimate was that the bridge tolls would yield from £140,000 to £200,000 a year, but this estimate might not be fully realised, owing to the depressed state of trade. The making of the bridge is estimated to give employment amounting to 7000 man-years, and £300,000 of steel will be required for the work. It will be possible for the scheme to go forward if the modified assistance sought is provided.

Hull Omnibus Station Project.

A proposal for the erection of a central omnibus clearing station and garage, at an estimated cost of £115,732, is being considered by the Hull Corporation. The suggested site is contiguous to Paragon Railway Station and Ferensway. It is intended that in addition to the Corporation omnibuses, all privately owned omnibuses running into the city shall make use of the clearing station.

Cement Works Extension.

It is only three years since the Ketton Portland Cement Company, Ltd., opened its new cement works at Ketton, but the venture has been very successful, and the directors have decided to double the capacity of the plant in order to meet the increasing demand, and orders have been placed to the extent of £150,000. We understand that not less than 95 per cent. of this amount will be spent in this country. The Ketton cement is made from oolitic clay and limestone to be found in the famous Ketton freestone quarries in Rutland. It is expected that the work on the new plant will commence immediately.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE improving tone in the Cleveland pig iron trade continues, though there is rather a tendency for sales to taper off in view of the approach of the Christmas holidays. An encouraging feature of the market is that there is no apathy which might have been expected as a result of the war debts controversy. On the contrary, traders generally take a more cheerful view of the outlook. The position of the industry has steadily improved week by week since the beginning of November, and there is every indication that it will continue to gather strength for some weeks to come. The import duty has driven foreign pig iron sellers out of the market, and more and more business is coming to home producers. Anticipations of price concessions have been wholly abandoned, and as industrial needs are increasing, consumers are displaying greater readiness to enter into contracts for a few months ahead. Trade with Scotland is increasing, and export sales, though still difficult to negotiate, are on a better scale. Ironmasters adhere firmly to the fixed prices for Cleveland pig iron for the home trade, but are prepared to make slight concessions for export business, whilst Scottish consumers also enjoy preferential terms. The prices to the home trade are: No. 1 Cleveland foundry iron, 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d., and No. 4 forge, 57s.

Hematite Pig Iron.

Conditions in the East Coast hematite pig iron trade show a slight further improvement. Home and export business is expanding, and there is a fair amount of trade in forward deliveries, which would seem to point to continued demand. At some of the works stocks are coming down, but accumulations are still very heavy. Prices keep steady at 59s. for mixed numbers, and 59s. 6d. for No. 1 quality.

Ironmaking Materials.

Transactions in foreign ore are still few and small but demand should expand in the next few weeks, when a number of running contracts will be completed. Prices are now firmly based on best Bilbao Rubio at 15s. c.i.f. Tees, the freight being 4s. 9d. Supplies of blast-furnace coke for home use are not so large as they have been, and the price, after a long spell of easiness at 14s. 6d., has improved to 15s. The firmer tone is in harmony with the greater strength of other varieties, although no more furnaces have been restarted on the North-East Coast. Moreover, most of the furnace owners produce their own coke, so that only a limited quantity is required for the home market.

Manufactured Iron and Steel.

The manufactured iron and steel trade also reflects an improving tendency. In the semi-finished steel section some substantial orders have been booked, and if the demand is maintained it is highly probable that more steel-producing furnaces will be put into operation early in the New Year. There are now no sellers of foreign semis, the import duty and low value of sterling having ruled them out of the market. Overseas demand for manufactured steel is somewhat quieter, but producers are hopeful that it is merely a passing phase, and some encouragement is derived by makers of shipbuilding requisites from the order for two Portuguese warships to be built on the Tyne. Bridge-building and other constructional steel is well taken up, and there are a few more inquiries for railway material. Prices are firmly maintained. Consumers of scrap have difficulty in buying certain kinds at prices that have ruled of late. Heavy export sales have further strengthened the hands of sellers. Severe shortage of one or two descriptions of scrap seems not unlikely. Borings are 23s. 6d.; steel turnings, 28s. 6d.; light cast iron, 35s. to 36s.; heavy cast iron, 37s. 6d.; machinery metal, 40s.; and heavy steel 37s. 6d. to 40s.

The Coal Trade.

The Northern coal trade presents a very strong tone, and in most sections there is a particularly favourable tendency, which is encouraging the owners further to increase the output. Collieries and merchants are meeting with increasing inquiries, large steams being the most active feature. Prompt offers for supplies are keenly sought from day to day, but the chances of early delivery are not favourable, as output in Northumberland is fully booked for weeks ahead, and the stem sheets are very full. There is not likely to be any lost time for want of orders in the next three months. Several pits would welcome increased quotas, even if the county as a whole has not yet absorbed its allowance. Collieries with trade are not disposed to pay a shilling or more per ton for extra quotas to help them out. In Durham trade is improving, but the county is a good way from the quota line. Output is being increased by the employment of more men in some districts, and the termination of a dispute in one district will help production. Steam coals have not been in a better position for a long while, but business is becoming restricted owing to the difficulty shippers have in securing supplies both for prompt and over next month. December shipments are almost out of the question, but any lots becoming available are quickly snapped up at 14s. 6d. for best qualities. These brands also for next month are difficult to secure below that figure. Similarly, prime Wear steams are sold out, and any odd cargoes for this or next month are strongly held at a minimum of 16s. For Tyne prime steams 13s. 6d. is now asked, and at this figure there is little to be obtained. The demand for small steams is favourable, with prices firm at 8s. 6d.

to 9s. The demand for Durham gas coal continues fairly good, and although output could be increased, prices rule fully steady, with best qualities at 14s. 6d., and special Wear qualities firm at 15s. Secondary gas are steadier at 13s. 3d. to 13s. 6d. First quality bunker coals for shipment before the Christmas holidays continue in heavy demand, supplies being daily more difficult to obtain and prices, consequently, are hardening. Best descriptions are now up to 14s. 6d. for prompt, and to the end of the month 14s. 3d. to 14s. 6d. is obtainable. Secondary bunkers are in ample supply, but under increasing demands are steadier at 13s. 3d. to 13s. 6d. Coking unscreened remain a quiet section at 12s. 6d. to 13s. 3d. Substantial demands for foundry coke are coming forward and the present output is being fully absorbed, with prices firm. Patent oven are 15s. 6d. and superior brands are 16s. 6d. Gas coke is in demand, but scarce, and transactions are thus limited. Prices are firm at 18s. 6d. Coke nuts are in active request and firm at 17s. to 18s.

SCOTLAND.

(From our own Correspondent.)

Clyde Shipbuilding.

IT has just been announced that J. and C. Harrison, Ltd., London, have placed with Lithgows, Ltd., Port-Glasgow, an order for two cargo steamers of about 8250 tons deadweight each. Since August last the number of vessels built or on order at the Port-Glasgow yard for Messrs. Harrison now totals eight. The former vessels were specially designed to secure the utmost economy and with a view to still further economy it is understood that the propelling machinery of the new steamers will incorporate the Götaverken turbo-compressor system of steam engine economy. The British licensees for the Götaverken system are David Rowan and Co., Glasgow, who will supply the engines for the new vessel. A few inquiries have also been mentioned, which it is hoped will result in the placing of more orders for new tonnage.

Steel for Russia.

A cargo of about 5000 tons of steel will leave the Clyde within a day or two for the U.S.S.R. Nearly six similar shipments have been despatched from the West of Scotland within recent months.

Steel.

There is no change of importance in the Scottish steel market. The demand for heavy steel of all classes continues on restricted lines, and conditions are, if anything, quieter, in view of the approach of the Christmas and New Year holidays.

Steel Sheets.

The demand for light sheets is comparatively well maintained. Producers have sufficient orders for shipment to Far Eastern markets to keep plants occupied for several weeks. Heavy gauges and galvanised sheets are somewhat quieter.

Tubes.

Business in tubes is somewhat uneven. Hot rolled seamless tubes are busy, but a quieter tone has developed in the other sections.

Iron.

The volume of trade in bar iron and re-rolled steel bars has not improved so far, and the plants still work at about 40 per cent. of capacity. Bar iron is unchanged in price, with re-rolled bars quoted at £7 5s. home and £6 10s. per ton export.

Pig Iron.

The position in the pig iron trade is unchanged. The requirements of consumers are mostly met from stocks and the output of the two furnaces in operation. Consignments continue to arrive from India and England, last week's arrivals including 1600 tons from Calcutta and 1000 tons from Barrow and Millom.

Hematite Prices Reduced.

Scottish hematite has been reduced by 1s. 6d. and is now quoted at 66s. per ton. Other qualities are still named as follows:—Foundry No. 1, 70s.; and No. 3, 67s. 6d. per ton.

Coal.

The export market for Scottish coal remains extremely firm, and any small lots available for shipment this year fetch enhanced prices. It is probable that the production in Scotland will be severely curtailed during the last two weeks of this year, owing to the exhaustion of quota allocations, and the shortage of supplies already experienced is likely to become acute. Even now exporters are not only unable to offer limited quantities to consumers abroad, but experience considerable difficulty in completing shipments due. All screened fuels are almost fully booked, some qualities being off the market so far as this year is concerned. With the exception of double nuts in the Lothians, all washed stuffs maintain recent strength. Singles and pearls are being absorbed in considerable quantities by the London market. Aggregate shipments during the past week amounted to 241,438 tons, against 215,507 tons in the preceding week and 242,392 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

THE returns of the G.W.R. Company of shipments of coal and coke from the various ports under its control show an improvement upon the figures for the preceding week, but are still disappointing. The actual total was 369,815 tons, which was over 25,000 tons better than the preceding week, but compared with 466,977 tons for the corresponding period of last year. Last week's quantity would unquestionably have been decidedly larger, but for the fact that tonnage was completely driven out of position by the gale which raged, with the result that on Saturday last the returns showed that idle tipping appliances at the various docks numbered fifty-four. The prospects of there being much improvement over the week-end were not bright, in view of the continuance of the bad weather, so that it was not surprising to find that this week started with no less than fifty idle appliances. Swansea and Port Talbot were relatively better placed than the more eastern ports, as only four tips were idle at these two ports, and this figure was offset by the fact that at Swansea there were three steamers waiting to berth. At the steam coal ports, however, viz., Cardiff, Penarth, Barry, and Newport, the number of idle tipping appliances came to forty-six, which is unusually high for the beginning of any week. Whereas formerly it was not expected that there would be any undue loading pressure before Christmas, the probability is that between now and the holidays a good deal of the delayed tonnage will arrive up together, and cause a certain amount of congestion. While, however, the general situation has been made to some extent more interesting by the fact that all loading arrangements for this week and next have been dislocated, new business for early delivery provides no special feature. In regard to contract operations the position is more hopeful. Up to now there is no definite news confirming that the Algerian State Railways have purchased supplies of Welsh fuel, though it is expected, but in the case of the French State Railways it is understood on the market that about 200,000 tons of large and small coals have been bought for delivery over next year, and that in the case of the large coals the bulk of the order will be for Tredegar coals. The inquiry is also reported to be a shade better for South America, but a definite prospect of business for Spain is held out by reason of the fact that the Madrid, Zaragoasa and Alicante Railway has come on the market for prices for 50,000 tons of large and small coals for delivery over the first six months of next year at Barcelona, Alicante, and Carthagena. Prices have had to go in promptly, so before the end of this week it is likely that news will be to hand of the placing of the order.

Barter Business and Other Items.

Reference was made recently to the negotiation of business on the basis of barter in respect of coals for Newfoundland with pit props in return. It is now definite that this business has been arranged between the Newfoundland Railways and Gueret, Llewellyn and Merrett, Ltd., of Cardiff. It appears that 40,000 tons of Welsh coals are to be exchanged for 76,000 tons of pit props, and offers of freight for the lifting of the coal and pit props between May and September of next year are being invited. The ports at which the coals are to be discharged are St. Johns, Argentia, Clarenville, Humbermouth, and Lewisport, while the pit props are to be delivered at Bristol Channel ports. It is understood that the basis of the exchange of these commodities is that the value of the coal is calculated at 5 dollars per ton c.i.f. and the wood at 5 dollars per cord f.o.b. The result of the transaction is that the Welsh coal will to a material extent supplant Canadian coal used on the Newfoundland Railway. The official announcement was recently made that, as has been the case for several months past, the French maritime ports have been granted the additional allocation of 100,000 tons of domestic coals for the current month, as well as 25,000 tons of anthracite and semi-bituminous coals for the ports in Normandy. Of the additional 100,000 tons, Great Britain has been apportioned 53,000 tons, the balance going to Holland, Germany, Poland, and Russia. It is also understood that there is to be an increase in the Belgian coal import quota during the present month from 55·7 per cent. of the basis period—viz., the first half of 1930—to practically 62 per cent. of the basis period.

Order for Local Iron Ore.

For some time past efforts have been made to obtain a measure of protection for home-produced iron ore, in view of the unemployment prevailing in this area. Now, however, comes the welcome news that the British (Guest, Keen and Baldwins) Iron and Steel Company, Ltd., has placed an order with the Llanharry Hematite Company for the supply of 2000 tons of hematite per week throughout next year. According to the agent for the Pontypridd district of the South Wales Miners' Federation, to which the Llanharry iron ore miners belong, the result of this order will be that 300 men who had been thrown out of employment by the closing down some months ago of the mine will be re-absorbed, and the situation will be as before the stoppage. If worked fully, the mine could employ between 500 and 600 men. It is stated that the maximum quantity of South Wales ore consumed by South Wales steel works is only 15 per cent., whereas for the whole country 75 per cent. of home-produced ore is used.

Steel and Tin-plates.

A week or so ago the head offices of the British (Guest, Keen and Baldwins) Iron and Steel Company were removed from Cardiff to Port Talbot, in view of the fact that this important company is centralising its efforts at that end of South Wales for the time being, and at a function in connection with the Margam Works, belonging to the company, the statement was made that they were on the eve of a happy and considerable change industrially in Port Talbot. The coke ovens were to be restarted after a long period of idleness, and it was probable that the second blast-furnace would shortly be put into operation. A healthier tone exists in the tin-plate industry, orders being more numerous for execution over next year. The Villiers Tin-plate Works were due to be restarted on Monday of this week, as also the galvanising section of the Whitford Steel Sheet and Ironworks. The Gwalia Tin-plate Works resumed last Monday week, and there is the possibility of the Cwmfelin Works at Swansea, belonging to Messrs. Richard Thomas and Co., making a restart early in the New Year. The tin-plate makers of South Wales are keenly alive to the importance of research, and on Thursday of last week their Research Committee paid a visit to the Melingriffith Tin-plate Works at Whitchurch, near Cardiff, for the purpose of inspecting a new boshing machine, invented by Mr. W. R. Davies, the works director. This machine has been specially designed for the purpose of cleansing the bars, and removing the scale and dirt before the hot rolling process. The Committee was welcomed at the works by Mr. H. Spence-Thomas, the managing director, and others.

Trade Development.

The South Wales and Monmouthshire Regional and Industrial Council are making a strenuous effort to revive the trade activity in this area, and they are directing their energy on the lines which have been signally successful in Birmingham. Councillor George Williams, the Chairman of the Cardiff Development Committee, is a live wire associated with the movement. Conferences are to be convened in the various districts of manufacturers and distributors, and hopes are entertained of building up a chain of new industries, and so gradually reducing unemployment. Negotiations are in progress with leading banks for a loan for development purposes, the idea being to afford small tradesmen and craftsmen financial assistance to extend their activities, and provide capital for enterprising firms or individuals who can show good prospects of establishing new manufacturing industries in this area. Various new committees are to be formed, such as parliamentary, research, education, railway, shipping, and transport committees, so that every interest can be watched.

Current Business.

Fresh inquiries for coal for prompt loading are far from numerous, and the chief trouble of most collieries is the absence of ready tonnage, more especially as, owing to the bad weather, steamers which should have put in an appearance days ago have not yet arrived. The result is that loading pressure is likely to be experienced during the week before the holidays. All qualities of sized coals continue firm, but most descriptions of large coal are offered freely. Coke is a steadier market, and there is no change in patent fuel. Pitwood is very scarce for early delivery, and prices are about 25s. to 25s. 6d.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. CHAS. E. HART, A.M.I.E.E., of 197, Bath-street, Glasgow, C. 2, has been appointed sole selling agent of Switchgear and Cowans, Ltd., of Old Trafford, Manchester, for the whole of Scotland.

RICHTER AND PICKIS, 6, Crescent, Minories, London, E.C.3, inform us that they have now completed arrangements whereby "Ricanpick" bucket ladder excavators for gravel, clay, chalk, and overburden are being made solely by Stothert and Pitt, Ltd., of Bath.

MR. JOHN R. HULLAH has recently joined the outside sales staff of Bruce Peebles and Co., Ltd., engineers, Edinburgh. His appointment dates as from December 1st. Mr. Hullah will operate in the Yorkshire area and his address is 21, Hightborne-avenue, Fagley, Bradford.

PETER BROTHERHOOD, Ltd., Peterborough, ask us to state that from December 21st its London offices will be transferred from 34, Victoria-street, S.W.1, to more convenient premises at Amberley House, Norfolk-street, W.C.2. Telephone number, Temple Bar 8914; telegraphic address, "Brotherhood, Estrand."

MR. H. E. PARTRIDGE, A.M.I. Mech. E., who has been associated with John Thompson Water Tube Boilers, Ltd., Wolverhampton, for many years, has now joined the board of Mitchell Graham and Son, Ltd., electrical and mechanical engineers, of Edinburgh. Arrangements have been made whereby that firm will represent John Thompson Water Tube Boilers, Ltd., for the Scottish and North of England areas.

BIRMINGHAM ELECTRIC FURNACES, Ltd., Birlec Works, Tyburn-road, Erdington, Birmingham, and Wild Barfield Electric Furnaces, Ltd., Elecfurn Works, North-road, Holloway, N.7, have recently reached an agreement between themselves for the interchange of information and rights under their respective patents and patent applications relating to electric furnaces employing centrifugal fans, and to the air circulation methods used with such fans.

CALENDARS, DIARIES, &c.

ARMSTRONG, WHITWORTH AND CO., Ltd., Sir W. G., Newcastle-upon-Tyne.— Wall calendar.

ASSOCIATED BRITISH MACHINE TOOL MAKERS, Ltd., 17, Grosvenor-gardens, S.W.1.—Wall calendar.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.—Pocket diary from the *Draughtsman*.

WILLIAM BAIRD AND SON, Ltd., Glasgow.—Wall calendar.

BRAITHWAITE AND CO. (ENGINEERS), Ltd., Broadway Buildings, Westminster, S.W.1.—Pocket diary.

BRISTOL AEROPLANE COMPANY, Ltd., Filton, Bristol.—Wall calendar.

THE HOUSE OF LISTER.—The yearly gathering of the friends of R. A. Lister and Co., Ltd., of Dursley, which is arranged to take place about the time of the Smithfield Show, was held at the Café Royal, London, on Wednesday evening, December 7th. Mr. C. Percy Lister took the chair, and presided over a large and enthusiastic company. The principal guest of the evening was His Highness the Maharaja Jamsaheb of Nawanagar, who, in a felicitous speech, proposed the toast of "British Industry," and referred to the problem of Indian trade. He suggested that efforts expended to promote trade with those parts of India ruled by the Indian Princes would yield earlier and more satisfactory results than would undivided attention paid only to the claims of Bombay, Calcutta, Karachi, and Madras, and other large towns. Even more popular were the speaker's authoritative remarks, as "Ranji," on the happy result of the first test match. In his reply, Mr. C. Percy Lister related some of his recent experiences in America, and spoke of the firm's excellent trading year, and the necessity for extending the works. The toast of "The House of Lister" was proposed by Mr. T. Hutchison, and Mr. R. B. Lister responded. The Lister Works Band, under the direction of Mr. H. H. Hoyle, gave selections of music during the evening, and after the dinner the guests left in motor omnibuses for the Saville Theatre, where the musical play "Tell Her the Truth" was greatly enjoyed.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	15/6 to 20/–
(1) Spanish	17/– to 24/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	15/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 7 6	—
No. 1 Foundry	3 10 0	—
No. 3 Foundry	3 7 6	—
N.E. COAST—		
Hematite Mixed Nos.	2 19 0	2 19 0
No. 1	2 19 6	2 19 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold-blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (*a*); 4 0 6 (*b*); 4 5 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	9 5 0	—
Best Bars	10 5 0	—
Double Best Bars	10 15 0	—
Treble Best Bars	11 5 0	—
LANCS.—		
Crown Bars	9 15 0	—
Best Bars	10 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 0 0 to 9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 0 0 to 8 10 0	—
Gas Tube Strip	10 7 6 to 10 10 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ¾in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.)	11 5 0—10 Ton Lots and Upwards Delivered Glasgow Stations.	10 0 0
„ (Gal. Cor. 24 B.G.)	For Canada	10 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 10 0	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	5 15 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 0 0 to 7 5 0	—
Small Re-rolled Bars	6 15 0	—
Billets and Sheet Bars	4 17 6 to 5 7 6	—
Galv. Sheets	11 5 0 to 13 5 0	10 0 0
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 7 6 to 8 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	f.o.b. 15/9 to 16/3
Block Tin (cash)	149 12 6
„ (three months)	150 15 0
Copper (cash)	28 0 0
„ (three months)	28 7 6
Spanish Lead (cash)	11 0 0
„ „ (three months)	11 8 9
Spelter (cash)	15 1 3
„ (three months)	15 3 9
MANCHESTER—	
Copper, Best Selected Ingots	33 15 0
„ Electrolytic	34 10 0
„ Strong Sheets	65 0 0
„ Tubes (Basis Price), lb.	0 0 10
Brass Tubes (Basis Price), lb.	0 0 9
„ Condenser, lb.	0 0 11½
Lead, English	12 17 6
„ Foreign	11 7 6
Spelter	15 7 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/7½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 15 0	8/–
„ „ 6 p.c. to 8 p.c.	£24 10 0	7/6
„ „ 8 p.c. to 10 p.c.	£22 5 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 10 0	11/–
„ „ „ 1 p.c. carbon	£42 12 0	14/–
„ „ „ 0·70 p.c. carbon	£44 0 0	16/–
„ „ „ carbon free	1/– per lb.	
Metallic Chromium	2/9 per lb.	
Ferro Manganese (per ton)	£10 15 0 for home	
„ „ „	£9 15 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£13 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 10 0 scale 6/– per unit	
„ Vanadium	12/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£245 0 0	
Ferro Cobalt	7/9 per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/–
„ „ Ell	15/6
„ „ Splint	15/6 to 17/–
„ „ Trebles	15/– to 16/–
„ „ Doubles	12/6 to 13/–
„ „ Singles	11/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/6
„ „ Jewel	16/6
„ „ Trebles	15/6 to 16/–
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/– to 15/–
Screened Navigation	16/6 to 17/6
Trebles	17/– to 18/6
Doubles	13/6 to 14/6
Singles	11/6 to 12/–
LOTHIANS—	
(f.o.b. Leith)—Best Steam	14/–
Secondary Steam	13/6
Trebles	15/6 to 16/–
Doubles	12/– to 12/6
Singles	11/3 to 11/6

(8) N.W. COAST— ENGLAND.

	Export.
Steams	20/6 to 23/6
Household	32/6 to 52/6
Coke	19/– to 22/6
NORTHUMBERLAND—	
Best Steams	14/6
Second Steams	12/6 to 12/9
Steam Smalls	8/6
Unscreened	12/6 to 13/–
Household	27/– to 39/–
DURHAM—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–

SHEFFIELD—	Inland.
Best Hand-picked Branch	27/– to 28/–
South Yorkshire Best	23/– to 24/–
South Yorkshire Seconds	18/– to 21/–
Derbyshire Best House	22/– to 23/6
Derbyshire Best Brights	18/– to 20/–
Screened Seconds	17/6 to 19/–
Kitchen Coal	16/6 to 17/6
Best Screened Nuts	17/6 to 18/6
Small Screened Nuts	16/– to 16/6
Yorkshire Hards	17/– to 18/–
Derbyshire Hards	17/– to 18/–
Rough Slacks	8/6 to 9/6
Nutty Slacks	7/– to 8/6
Blast-furnace Coke (Inland)	10/– on rail at ovens
Furnace and Foundry Coke (Export), f.o.b., 14/6 to 15/6	

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	20/– to 32/–
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	20/–
Pitwood (ex ship)	24/6 to 25/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 34/–
Red Vein	22/– to 26/6
Machine-made Cobbles	37/6 to 48/6
Nuts	36/6 to 48/6
Beans	28/6 to 32/6
Peas	19/6 to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/6 to 9/–
Steam Coals:	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Public Works.

THERE is apparently no means of helping the manufacturing industries except by carrying out the programme of public works. Nothing can be hoped for from private initiative so long as there exists an entire lack of confidence, and nothing at present indicates a likely return of that confidence which will release capital for investment in enterprises involving an expenditure on structural and other material. If the Government's scheme is to be effective in dealing with the crisis it must be put in hand immediately, and it must be sufficiently comprehensive to provide employment where it is most needed. The programme is now before Parliament, where it is undergoing a long discussion, principally by the Socialist party, which does not consider that it goes far enough. Of the 7805 million francs which it is proposed to devote to works of all kinds during the next two years, about one-third is allotted to the Ministry of Public Works which proposes to spend 1150 millions on roads and bridges, 328 millions on inland waterways, 708 millions on harbours, and 356 millions on hydro-electric supply. In view of the material already existing at some of the ports, it is by no means certain that any large amount of new plant and machinery will be required for harbour extensions. Cherbourg is to be provided with a deep basin for big liners, and at Saint-Nazaire the combined lock and dry dock will be completed and the channel deepened to allow of the "Normandie" leaving the Penhoët shipyard. It appears that work on the Verdon mole at the mouth of the Gironde has been suspended, like other undertakings, through lack of funds, and the programme provides for its early completion. The Chavenon barrage on the Upper Dordogne, the Pannessière dam for the reservoir on the upper reaches of the Seine, and the Sautet dam on the Drac, which is noteworthy for its height, will also be put in hand. It is doubtful whether these undertakings will bring any remarkable activity to the engineering trades. It is suggested even that, as these works are intended primarily to relieve unemployment, it may be desirable to use as little machinery as possible.

Railway Electrification.

The electrification of railways is regarded as a useful factor in helping to tide over the economic crisis, but in France the idea of transforming all the railway systems in this way has lost much of the favour it once enjoyed. The problem is now being approached with more caution. In Belgium the industrial situation has become so desperate that Monsieur Forthomme, Minister of Transport, is advocating electrification as a means of helping industry because the whole of the material, both raw and finished, can be provided in the country, while copper would be supplied by the Congo. It would, he said, benefit a considerable number of industries besides electrical engineering. Monsieur Forthomme argues that, so far as goods are concerned, there is little difference in the cost of steam and electric traction, but when losses fall so heavily on passenger traffic the only solution in a country like Belgium is to increase such traffic by running frequent services of single coaches. The National Railways own seven rail motors, and soon after they were put in service the number of passengers more than trebled. Hence, Monsieur Forthomme concludes that in a densely populated country frequent services of light electric trains could be expected to solve the problem of railway deficits, while a transformation of the system would provide acceptable industrial activity.

Shipping Tonnage.

The decision of the international committee of shipowners at the recent meeting in Paris to appoint a sub-committee in order to see what measures could be taken to obtain a suppression of State bounties for shipbuilding and for shipping, with a view to the preparation of a general plan for the scrapping of superfluous tonnage, has been examined by the Association des Grands Ports Français. It has passed a resolution recommending that Governments should return progressively to a liberal system of commercial exchanges between nations, and that an arrangement should be come to amongst shipowners of the leading maritime Powers, and opened to shipowners of all other countries, for an adjustment of "sea transport possibilities to the importance of the goods and passengers to be carried." The carrying out of the agreement should be subjected to close and impartial control, it being understood that the measures taken will not prejudice any changes or developments that may arise as the result of customers' requirements, competition, and technical progress, and that consequently each shipowner will be free to organise his fleet in the most useful and economical manner. Finally, financial compensations in the form of bounties, subsidies, &c., which may be granted to shipowners, directly or indirectly, should be fixed in such a way that shipowners would not be encouraged to profit from those bounties rather than be guided by traffic requirements. Any solution must take into account the fact that shipping and shipbuilding have an essentially international character. The wording of this resolution suggests that the Association des Grands Ports Français links the scrapping of superfluous tonnage with the plans to promote economic revival, and that there is no question of suppressing State financial aid to shipbuilders and shipowners, while the reference to shipbuilding and shipping as international industries is apparently intended to lessen the claims of some maritime countries to more favourable treatment than others.

Russian Orders.

Since the signing of the political convention between France and the Soviet Government there have been statements of important orders being placed by Russia in France. These reports are taken to be the usual Russian propaganda that is launched when commercial negotiations are in progress, the object of which is to create a favourable atmosphere for the granting of credits. Notwithstanding the keen desire of French manufacturers to obtain orders from Russia, they are doubtful whether the conditions under which such orders are offered will prove acceptable.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

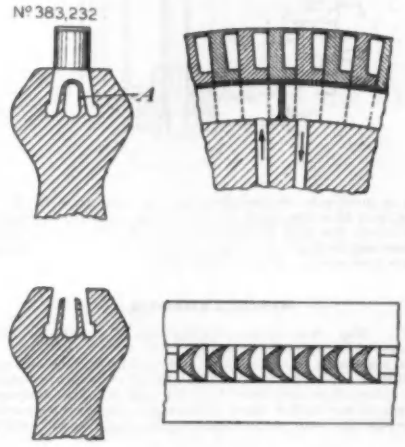
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.

383,232. July 4th, 1932.—COOLING THE BLADING OF INTERNAL COMBUSTION TURBINES, H. Holzwarth, Goethestrasse 7, Düsseldorf, Germany.

It is suggested that the best means of cooling the blades of internal combustion turbines is to cool them at the roots only. This is an elaborate specification, and runs to seven pages, while there are many illustrations, but those reproduced seem

Nº 383,232

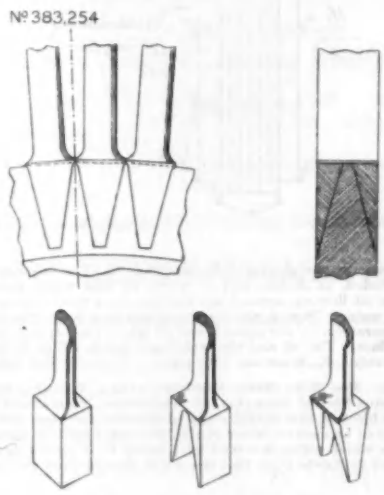


to be the most interesting. They represent the rim of a turbine disc, in which the blades are fixed by expanded roots, being put in place circumferentially from filling openings. The roots of the blades are cooled by circulating water through a duct A, which is made by turning a groove in the rim, and then bending over the top edges, as shown. The joint is then soldered or welded.—*November 10th*, 1932.

383,254. September 29th, 1932.—STEAM TURBINE BLADING, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

This invention is chiefly concerned with the low-pressure stages of the blading of steam turbines, where the centrifugal stresses in the blades are high. The blades are formed with two

Nº 383,254



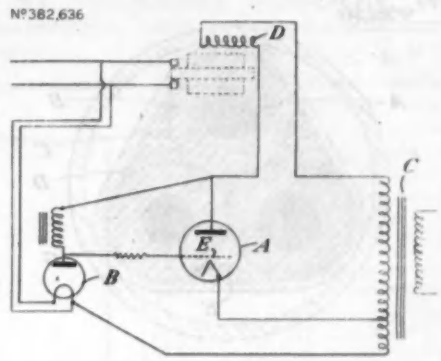
pyramidal legs, which straddle the V-shaped edge of the turbine disc. The intervening spaces are then filled in solid with welding metal. The arrangement, it is said, allows a very substantial attachment of each blade to the wheel, so that even if some of the welding is defective the remainder will hold the blade.—*November 10th*, 1932.

DYNAMOS AND MOTORS.

382,636. July 28th, 1931.—REGULATING DEVICES FOR DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2, and Leonard John Davies, of 147, Murray-road, Rugby.

In accordance with this invention the field current of a generator or of an exciter therefor is supplied through an electrostatically controlled vapour electric or arc discharge device A, and the flow of current through the device is controlled by a thermionic diode B, the cathode heating current of which is adjusted in accordance with the characteristic to be regulated. The grid controlled vapour electric discharge device A is connected in an alternating-current circuit, represented by the secondary winding of a transformer C in series with the field winding D of the generator to be controlled, so that when the alternating voltage is supplied pulses of direct current will pass through the field. The amount of direct current that will pass will depend upon the voltage applied to the electro-static control electrode or grid E of the vapour electric discharge device, and also upon the phase relationship of this voltage with respect to the voltage applied to the anode. The phase of the grid voltage can be varied in a number of ways, one of which is to interconnect the grid with the anode supply voltage in a phase-shifting circuit containing inductance and resistance, and alterations in the value of either the inductance and resistance, or both, will produce variations in the phase relation of the grid with respect to the anode. Variations of the output voltage of the generator will produce variations in the temperature of the cathode of the diode, which, in turn, will vary the thermionic emission of the cathode, and so produce changes in the resistance of the cathode-anode path of the diode. The changes

Nº 382,636



of resistance of the diode react on the anode current of the vapour electric discharge device A, by causing a change in phase between the grid and anode potentials of the latter, and an increase in the voltage of the generator will cause a decrease in the anode current of the vapour electric discharge device.—*October 26th*, 1932.

382,616. July 25th, 1931.—COVER PLATE FOR THE BEARINGS OF ELECTRICAL MACHINES, *William Edward Evans, of 27, Chancery-lane, London, W.C.2.*

For reasons of economy and in order to reduce weight, the cover plates of electrical machines are frequently made of drawn sheet metal. According to the invention, the bearing cover plate of drawn sheet metal is retained, when a cast bearing housing is used, and is so formed that it can be used for bearing housings, whether of cast iron or of drawn sheet metal. The shaft of an

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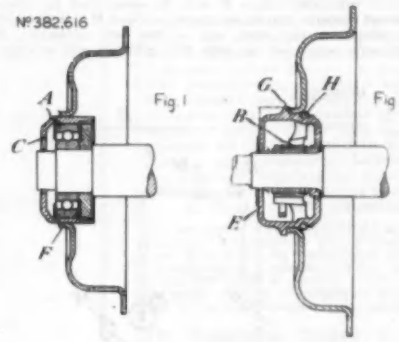

electrical machine is mounted in a ball bearing A (Fig. 1) or in a sliding bearing B (Fig. 2). The ball bearing A is enclosed in a housing C of sheet metal, and the sliding bearing B in a housing E, made of cast metal. The bearing housings are slipped into the hole bored out in a sheet metal cover plate, having a widely flanged inner rim F, and this rim forms a cylindrical surface large enough to serve as a seating surface. The casting E also has a centering ridge G, and it is maintained in position by a resilient ring H, sprung into position in a peripheral channel or recess formed upon the casing E.—*October 25th*, 1932.

TRANSMISSION OF POWER.

382,225. April 23rd, 1932.—REVERSING AND REDUCTION GEARING, Société Anonyme des Engrenages Citroen, 31, Quai de Grenelle, Paris.

One of the objects of the design of this gear-box is to enable the meshing of the teeth of a double-mitre reversing gear to be adjusted. The driving shaft is shown at A and the driven at B.

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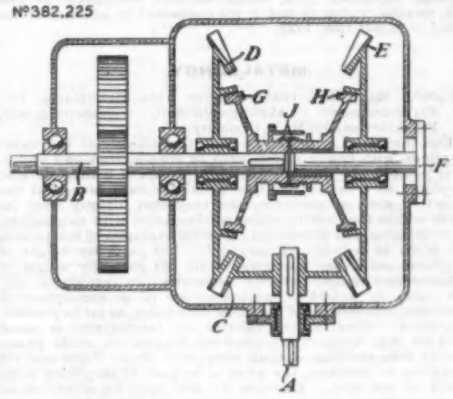

The mitre wheel C on the driver meshes with the loose wheels D and E. The adjustment with D is effected by a movement of the driving shaft. The adjustment of C and E by movement of the stub shaft F on which E is mounted. The drive in one direction is from A through C, D and the friction clutch G to B. The reverse is effected from A through C, E, the clutch H, and the flexible coupling J.—*October 20th*, 1932.

382,344. August 12th, 1931.—ELECTRIC CABLES, Callender's Cable and Construction Company, Ltd., and Philip Vassar Hunter, both of Hamilton House, Victoria Embankment, London, E.C.4.

This invention relates to electric cables, primarily for high tension and of the kind insulated by permeable impregnated material, such as paper. The invention provides improved means for dealing with the difficulties which arise, owing to the change of volume of the impregnating liquid or semi-liquid, such as oil or compound, which takes place as the temperature of the cable varies. In the case of the example of the invention shown, each core consists of the stranded conductors A and

impregnated paper insulation B. Each core has an outer conductive layer C, which may consist of a metal tape or may be of metallised paper, the three layers being in contact with each other. The three cores are held together by a metal tape D, and between the cores are interposed fillings E made of paper or other suitable material. The whole forms a body of sub-

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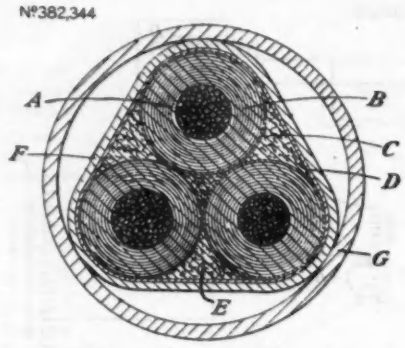

stantially triangular shape, and this is enclosed within a correspondingly shaped lead sheath F, the cores fitting into the rounded corners of the sheath. The inner sheath F and its contents are enclosed within an outer lead sheath G, the dimensions of the outer sheath being such that the rounded portions of the inner sheath are in contact with the inner surface of the outer sheath.—*October 27th*, 1932.

MEASURING AND TESTING INSTRUMENTS.

382,933. August 15th, 1932.—DEVICES FOR DETERMINING THE PHASE OF AN ALTERNATING VOLTAGE, *International General Electric Company, Incorporated, of* 120, *Broadway, New York, U.S.A.*

In the drawing A and B are A.C. networks to be coupled together by an oil switch C. A disc D rotated by a motor M carries two luminous tubes E and F, connected to receive their current from the condenser coatings G and H. If the motor M runs synchronously with one of the two networks, the luminous tube connected up with this network will produce a

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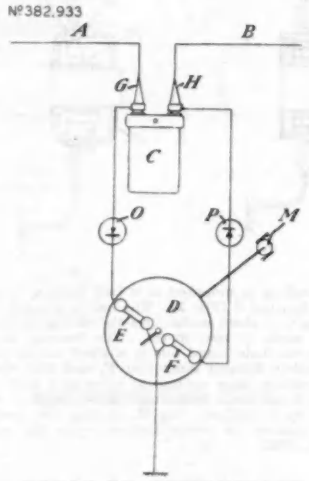

steady luminous strip or zone, because it lights up for a short time only during each half wave, the width of the strip depending on the duration of the illumination. If the voltages of the networks are not synchronous, then the strip produced by the luminous tube F will move away from that produced by the tube E. As soon as the stripe coincide a correspondence of the phase position prevails. Since the tubes light up during each half wave, it is preferable to take precaution in order to enable a phase opposition to be recognised with certainty. To this end, suitable valves O and P are connected in advance of the tubes.—*August 15th*, 1932.

METALLURGY.

383,200. May 12th, 1932.—ALLOYS WITH BERYLLIUM, I.G. Farbenindustrie Aktiengesellschaft, Grüneburgplatz, Frankfurt-on-the-Main, Germany.

This invention is concerned with the alloying of the metal beryllium with heavy metals such as copper, iron and nickel. It is pointed out that the known processes of adding metallic beryllium to a bath of the base metal are expensive, and the invention aims at providing the beryllium directly from its oxide within the bath by reducing that oxide with magnesium, or magnesium and aluminium. Several examples of the process are given as follows:—Example 1: 150 parts by weight of beryllium oxide are briquetted with 160 parts by weight of magnesium turnings, and the briquettes are introduced into 400 parts by weight of molten copper in an atmosphere of hydrogen, overheating of the metal bath being, as far as possible, prevented. After the introduction the temperature is raised to 1300 deg. Cent. The resulting magnesium oxide passes readily into the slag, and an alloy with about 7 per cent. of beryllium is obtained, the yield in respect of beryllium being about 67 per cent. Example 2: 100 parts by weight of an alloy containing 25 per cent. of magnesium and 75 per cent. of copper are melted, and 30 parts by weight of beryllium oxide are stirred in. After the reaction has terminated, the temperature is raised to about 1400 deg. Cent., in order to vaporise the excess of magnesium. A beryllium-copper alloy with 5·7 per cent. of Bé is obtained, the yield in respect of beryllium being 52·8 per cent. Example 3: A mixture of 100 parts by weight of beryllium oxide and 100 parts by weight of an alloy containing about equal parts by weight of magnesium and aluminium, in the form of filings, is formed into briquettes of about 1 to 10 cubic inches size by applying a high pressure and the briquettes are introduced while stirring into 500 parts by weight of molten iron at about 1600 deg. Cent. An iron-beryllium alloy is obtained containing 6·5 per cent. of beryllium, the yield in beryllium amounting to 75 per cent. of the input. Example 4: In the same manner a beryllium-nickel alloy, containing about 9·5 per cent. of beryllium with a yield in beryllium of 70 per cent. is obtained by introducing a mixture of 100 parts by weight of beryllium fluoride and 100 parts by weight of magnesium metal filings into 200 parts by weight of molten nickel at a temperature of about 1550 deg. Cent.—*November 10th*, 1932.

PUMPING AND BLOWING MACHINERY.

382,567. May 10th, 1932.—ROTARY BLOWERS, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

This blower is of the type with an excentric rotor and a sliding vane. The peculiarity lies in the arrangement of the vane A,

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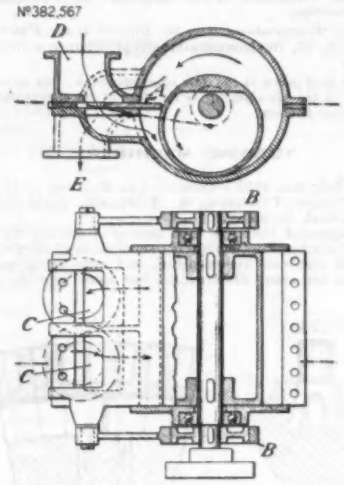

which is positively reciprocated by the excentrics B, B. It will be seen that the vane is pierced by ports C, C, where it passes across the inlet D and the outlet E. It is claimed that the vane may be made very light, and, consequently, the blower run at a high speed.—*October 27th*, 1932.

MISCELLANEOUS.

382,891. May 6th, 1932.—SEPARATORS, C. Still, Recklinghausen, Westphalia, Germany.

This apparatus is for cooling and separating out mixtures of distillates of oils and water. The light oil vapours are supplied to the counterflow condenser A by the pipe B. The condensate is drawn off at C and is taken to the inner part of the separator by the pipe D. Any uncondensed vapour finds its way into the

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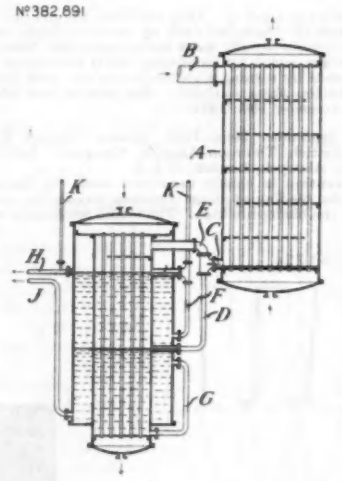

upper part of the separator by the pipe E. The separator is water-cooled, as shown, and in it the oil and water separate out, the oil flowing upward against the downward flow of the cooling water. The oil and the water are then led to the outer part separately, by the pipes F and G, where further separation takes place. The oil and the water are drawn off at H and J respectively. K, K are air vent pipes.—*November 3rd*, 1932.

383,196. May 9th, 1932.—ELECTRIC STEAM BOILERS, Sulzer Frères Société Anonyme, of Winterthur, Switzerland.

The object of this invention is to increase the steam-raising capacity of an electric boiler of the electrode type. A nozzle A through which water is forced by a pump C, is placed close to the inner electrode B, so that the water flowing from the nozzle

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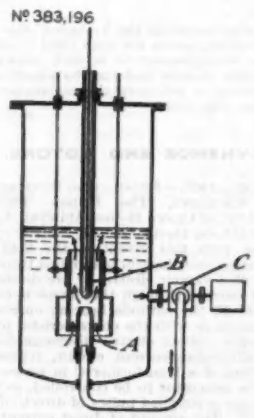

impinges on and cools the part of the electrode where the current density is at a maximum. The nozzle and/or a part of the pipe leading to it is made of insulating material. Although a single-phase boiler is illustrated, the invention is equally applicable to a multi-phase boiler, in which case an appropriate number of pipes or branches would be provided for directing water on to several electrodes.—*November 10th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN.—Old Assembly Rooms, Westgate-road, Newcastle-upon-Tyne. Annual dinner. 7 for 7.30 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "Piston Temperatures in a Solid-injection Oil Engine, and Experiments on a Supercharged Single-cylinder High-speed Petrol Engine," Dr. G. F. Mucklow. 6 p.m.

INST. OF MUNICIPAL AND COUNTY ENGINEERS.—84, Eccleston-square, Westminster, S.W.1. "Heavy Traffic—Light Traffic," Dr. P. E. Spielmann. 6.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Manufacture of Photographic Films," Dr. H. Baines. 7.30 p.m.

PHYSICAL SOCIETY.—Imperial College of Science and Technology, South Kensington, S.W.7. Meeting. 5 p.m.

RAILWAY CLUB.—Broad-street Station Restaurant. Twenty-sixth annual dinner.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Sir George Macdonald. 9 p.m.

SATURDAY, DECEMBER 17TH.

INST. OF CIVIL ENGINEERS.—Students' visit to Kempton Park Works of the Metropolitan Water Board.

MANCHESTER ASSOC. OF ENGINEERS.—College of Technology, Sackville-street, Manchester. Conversazione and dance. 6.45 p.m.

TUESDAY, DECEMBER 20TH.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Engineering Research at the National Physical Laboratory," Dr. H. J. Gough. 7.30 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. "Further Impressions of German Mining," Mr. H. O. Dixon. 3.30 p.m.

OLD CENTRALIANS.—Devereux Restaurant, Devereux-court, W.C.2. Luncheon. 1 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Reduction of the Emission of Smoke from Mill Furnaces," Mr. T. Stock. 7.30 p.m.

WEDNESDAY, DECEMBER 21ST.

CRYSTAL PALACE SCHOOL OF PRACTICAL ENGINEERING.—Crystal Palace, S.E. 180th Award of Certificates. Chairman, Mr. H. T. Creasy, C.B.E. 3 p.m.

INST. OF WELDING ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Essentials of Good Welding," Mr. A. G. Walker. 7.45 p.m.

ROYAL MICROSCOPICAL SOCIETY.—B.M.A. House, Tavistock-square, W.C.1. Meeting at 4.30 p.m.

FRIDAY, DECEMBER 30TH.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "The Design of Kilns for the Seasoning of Timber," Mr. E. A. Steel. 7.30 p.m.

1933.

FRIDAY, JANUARY 6TH.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Stress Recorders and their Use in Railway Bridge Work," Mr. G. F. Kent. 7.30 p.m.

THURSDAY, JANUARY 12TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. "The Zinc Industry," Mr. Stanley Robson. 7.30 p.m.

FRIDAY, JANUARY 13TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "Compression-ignition Locomotive and its Applicability to the British Railways," Lt.-Col. L. F. R. Fell, D.S.O. 6 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION (Joint meeting with Society of Chemical Industry).—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Corrosion of Metals in Salt Solutions and Sea Water," Dr. G. D. Bengough. 7.30 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-Ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Metal Spraying," Mr. Kenneth Gray. 7.30 p.m.

MONDAY, JANUARY 16TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Aluminium-bronze," Mr. F. Hudson. 7.30 p.m.

THURSDAY, JANUARY 19TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the University, Edmund-street, Birmingham. "Moulding Sands," Dr. J. G. A. Skerl. 7 p.m.

THURSDAY, JANUARY 26TH.

INST. OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Royal Victoria Station Hotel, Sheffield. Annual dinner. 6.30 for 7 p.m.

CONTRACTS.

JOHN I. THORNYCROFT AND CO., Ltd., have secured another order for a motor yacht, the second to be placed with them this month, which will make three ocean-going private yachts undergoing construction in the Thornycroft yards. This latest order is for a 90ft. vessel with a beam of 15ft. 6in. and draught of 5ft. The machinery will comprise two Thornycroft RL/6 six-cylinder oil engines with reducing gears, each developing 126 B.H.P. With this power the boat is expected to attain a speed of about 12½ knots.

COASTWISE SHIPPING MEDAL, 1933.—The Institute of Transport invites contributions in competition for a Coastwise Shipping Medal, donated by Sir Alfred Read, a former Vice-president. The medal, which will be in silver, will be awarded for the contribution judged first in order of merit on the prescribed subject, "The British Coasting Trade and its National Importance." The writer of any contribution submitted must be a member of the Institute. Contributions must be delivered to the secretary of the Institute not later than May 31st, 1933. Further particulars can be obtained from the secretary of the Institute at 15, Savoy-street, London, W.C.2.